ENGINEERING NEWS.

Just 11 years and 75 days after the fall of the Ashtabula bridge comes the failure of another bridge, within the city limits of Boston, which was barely six months old when Ashtabula fell and which has managed to stand up and pass "inspection" ever since, although compared with it the Ashtabula bridge was a master-piece of engineering. In the presence of such a disaster it is well to call a spade a spade, and the full details of the structure which we publish this week, with the much fuller ones in our posession, more than justify this conclusion. For the Ashtabula bridge was at least a structure of symmetrical and careful design, and the separate members were of good quality and well made. Its defects were in details of design, and they were great, but it was admitted in evidence that the bridge had been an honest, if ill-judged, effort to advance the art of bridge construction. Again, there had been at no time before its fall a great catastrophe to enforce the importance of careful reinspections. What the painfully well named "Tin Bridge" was, appears more fully elsewhere.

The Ashtabula disaster happened on the night of Dec. 29, 1876, to a heavy train of 3 express and baggage cars, 5 passenger cars, and 3 sleepers, headed by two engines. The entire train, except the leading engine, which barely escaped, fell in one confused mass into the gorge and almost immediately caught fire, burning many alive. Of the 209 persons on the train, 92 were killed, 64 injured and 53 escaped uninjured. The bridge was a badly designed Howe truss, and 11 years old at the time of the disaster. The Roslindale or Forest Hill disaster, which will long make this week memorable, happened Monday, March 14, 1887, there being about 250 people on the train, of whom perhaps 170 went down with the wreck. Out of these some 32 appear to have been killed or have since died, and nearly all the rest were more or less injured, perhaps 60 or 70, enough to be ordinarily classed as injured. The Ashtabula disaster cost the road something over $600,000.

That this disaster should have happened so soon (40 days) after that at Woodstock has given many a terrifying sense of the danger of travel by rail, but it is nothing more than another proof that misfortunes never come singly. The Chicago fire was followed within a year by the Boston fire; Ashtabula within a year by Tarriffville; a dreadful scalding disaster on the Philadelphia & Atlantic City (Aug. 11, 1880) by another just like it at Pittsburg two months later; the Rio holocaust last winter by another at Republic, O., and again at Woodstock; and now Woodstock has been followed by Roslindale, but we may go ten years either way from these events without finding further parallels, and it is important to remember that from Ashtabula until now there has not been a single bridge failure in this country from inherent defect (for Tarriffville was not such) which caused a disaster of the first rank, and but very few of any kind due to entirely discreditable engineering defects. The fall of the Tay bridge has intervened (Dec. 28, 1879) killing every one of the 75 persons on the train, and also the most fatal disaster on record, the fall of the Morelos (Mexico) bridge, on July 1, 1881, in which 247 soldiers were killed, 40 injured and only 20 escaped uninjured of all those on the train; but these most discreditable of all bridge failures—until this one—happened on foreign soil. The entire sequence of events in this latter is now entirely clear, and, taking all the circumstances together, it shows it to be the least excusable bridge disaster of magnitude which has ever occurred. But it should in justice, be added, that for the worst acts of omission and commission we must go back ten or fifteen years.

THE *Railroad and Engineering Journal*, in gracefully acknowledging the error which "a contemporary" (meaning this journal) pointed out, as to its conclusion as to "less than one-half of one per cent." of the steam generated by the locomotive being needed to heat a train of 12 cars, calls our attention to a typographical error in our discussion of the same question, which may have puzzled some one besides our contemporary. After determining by figures for steam consumption that "from 2½ to 3½ per cent. of the total supply of steam is needed for heating" what we meant by the following sentence will be made clearer by the italicized correction below:

"The same result in substance is reached by remembering that *on one* square *foot* of grate surface (not "more square feet," as the compositor put it, at the instigation of the devil) an engine can comfortably burn 80 to 100 lbs. of coal per hour, or 1,360 to 1,700 lbs., and computing the horse-power from that, at 3 to 4 lbs. per hour."

In this connection it occurs to us that the problem of what to do with the state prison convicts, under the new law which cuts them off from work at stove-making, and that sort of thing, might be solved by setting them at work at proof-reading. An unending supply of proofs could be obtained from New York, or enough to supply Sing-Sing at least, and there are some thousands of editors and such like folk, who now have to read them, who would waive their dislike to convict competition for the public good. The taming and humiliating effect of the occupation would be just what is needed.

ANOTHER derailment from a broken rail on or near a bridge, this time on the Pemberton & Hightstown branch of the Pennsylvania Railroad, at Sharon, has caused another man to be burned to death by fire started from the car stoves, and several others to narrowly escape that fate. He has not died in vain, for it has renewed the interest in the question of car heating, which showed some signs of dying out with the general public. Fortunately, however, this is not so with the railways. The managers seem to have clearly perceived that the demand for something better has come to stay, and that the company which had the next holocaust, and was not able to show that it had done something to do away with the car stove, would find itself placed in a very awkward light before the public. This has led them to look into the matter with a very different mental attitude from heretofore, and as a consequence it is now generally admitted that the supposed difficulties of either supplying or distributing the steam from the locomotive are more imaginary than real. Unfortunately, this latest catastrophe has not been described with such fullness as to enable one to say whether a re railing bridge-guard would have prevented it altogether, but the indications are that it would.

IN our issue of March 5, we made a short note of rapid tunnel driving on the Colorado Midland R. R. We have since obtained some further particulars from the Engineer-in-charge. The Colorado Midland starts from Colorado Springs and runs through Ute Pass and Eleven Mile Canon to Leadville. There are nine tunnels in the Ute Pass, the longest being about 600 ft. No. 5, recently completed, is 515 ft. long; in this tunnel the run of 98½ ft. in one week, referred to previously, was made; this 8x16 ft. heading was commenced on Oct. 17, and completed on Nov. 17., the material being hard red granite, and only two Ingersoll "Eclipse" drills were used; size "*D*" 3 in. diameter of cylinder. The tunnel contractors were MCMURTRIE & STREETER. the tunnel superintendent was F. W. DASHE, and the engineer in charge of tunnels, WM. BEHRENS.

ON Feb. 26, Messrs. ARROL succeeded in getting the thirteenth and last main girder of the new Tay Bridge into position. So after nearly five years labor the counties of Forfar and Fife are once again practically connected by an iron railway bridge over two miles in length. In erecting this last span of 250 ft. in length and 560 tons in weight, the difference between the space between adjoining trusses and the span itself was only 14-in. It was floated into position upon pontoons, and after it was adjusted and the pontoons made fast the valves in the last were opened, and the truss lowered upon its temporary seats on the piers, from which it is to be lifted a further height of 80 ft. by hydraulic power to its final resting place.

The Railroad Commission of New York has turned its attention to the danger to brakemen from falling between cars and has issued a circular propounding to railroad officers the following: "From the liability of accidents occurring to brakemen falling between the ends of cars, the board regards it as its duty to ask the views of the railroad companies of the State as to the question whether or not it is practicable to provide a bridge or other device for all cars where brakes are operated from the top, which shall protect the brakemen from falling between the ends of the cars."

It is easy to foresee the substance of the answers;—that it is not at all practicable, and would cause more danger than it saved. The true solution to that problem, and it needs a solution, is the introduction of freight train brakes, which is sure to come and that before long, unless something unexpected should turn up at the ensuing Burlington brake tests. Not only humanity but economy requires it, for there is no doubt that a good train brake would save more than its cost in one way and another.

THE Tobey (Canadian) petitioners for the privilege of building the Cape Cod canal, are now having a hearing before a legislative committee in Massachusetts, and putting in a very earnest plea to be given a charter which requires them to pay in $2,000,000 within six months, paying back all previous expenditures of the opposing interest and executing the work under the supervision of the State. They appear to have the capital, and it seems to be generally thought that their chances are good for getting what they ask.

Kuhlow's German Trade Review is authority for saying that a convention of asphalte firms has met at Hanover, including the German Asphalte Co. The purpose of this syndicate is to do away with the ruinous competition now existing among the various firms. It is expected that asphalte prices will be increased about 30 per cent.

ANOTHER narrow-gauge line, the Dayton & Ironton, 167 miles long, is to be converted to standard gauge and extended to Belpre, opposite Parkersburg, W. Va. Thus, one by one, and very rapidly, the narrow-gauge lines are passing away, and all evidence of that ill-judged and short-lived movement is disappearing, except the only good which came of it, certain lessons which it taught engineers as to the possibilities in constructing both the roadbed and rolling-stock.

A project is on foot to connect the city of Quito, Ecuador, with the coast, the necessary ascent being 9,500 ft. and the distance, 120 miles. A concession granting a subsidy of $45,000 per mile has been made to two American engineers; but we advise no one to start for South America on the chances for employment.

The Smith & Owen Heater Co. are reported to be financially embarrassed, their hopes resting on their success in pursuading railways to adopt their heater. It is one of the very best car stove heaters ever devised, being made of boiler iron and very strong; but it would be a public calamity if even the best stove heater should be adopted, since nothing more is needed than care, study and a little experimenting to make steam heating from the locomotive an entire success.

IT is intended to have a further discussion of Mr. WILLIAM METCALF'S paper on "Steel, Some of its Properties; its use in Structures and in Heavy Guns," at the meeting of the American Society of Civil Engineers on Wednesday evening, April 6, and members and others are invited, to send discussions to the Secretary unless able to be personally present. It seems probable that the paper and discussion provoked thereby may have an effect on the action of the Government in the matter.

BRAZIL has 5,597 miles of railroad. The Argentine Republic has 3,994 miles, of which nearly half is controlled by the State and the Province of Buenos Ayres, the rest being owned by private companies. Bolivia has 23 miles of railroad; Chili, 1,377. Of the Chilian railways the State controls rather more than one-third. The railways of the United States of Colombia are 140 miles in length, and are controlled by private companies. Paraguay has 45 miles of railroad, and Peru 1560, Uruguay 270, and Venezuela 372 miles.

THE Russians are projecting a second connection between the Azof and Black seas by a canal through the Isthmus of Perekop, which connects the Crimea with the mainland. As proposed this canal would be 12 ft. deep and 65 ft. wide. It would avoid the dangerous navigation of the Straits of Kertch.

Engineering Surveying Instruments. Their Construction and Use.

BY I. O. BAKER, C. E., PROFESSOR OF CIVIL ENGINEERING UNIVERSITY OF ILLINOIS.

(*Concluded from Page* 169.)

VI.

8. THE ROD.—The rod must be light and handy for transportation. A board about 1-in. thick and 4 or 5 wide does very well; it may be stiffened by screwing a strip edgewise on the back. The rod may be hinged in the middle, folded for ease of transportation and for the protection of the graduation; when in use, it may be kept upright by a button or bolt on the back. It should be provided with a disk level, or a short plumb, for keeping it vertical. A handle is very useful in holding the rod steady.

As in leveling, there are two kinds of stadia rods, self-reading and target rods. The latter require two targets; one of them is sometimes permanently fixed to the rod to save the trouble of setting two targets, but, when the vertical co-ordinate is desired, this adds more complication than it saves. Target rods may be a little more accurate, but they are certainly very much less convenient. Self-reading stadia rods are generally preferred.

9. The principles involved in the graduation of stadia rods are much the same as those discussed for self-reading level rods; the only difference is that the latter are generally read at short distances, while it is frequently necessary to read the former at long distances. Hence, in graduating a stadia rod, visibility is of first importance.

It is generally stated that a red disk on a white ground can be seen by the unaided eye at about 6,000 times its own diameter. A black disk can be seen farther, and a black line still farther. A good telescope would increase this distance nearly in proportion to its magnifying power. To be on the safe side and allow for the loss of light in the telescope and for unfavorable atmospheric conditions, we will assume that a black line on a white ground will always be visible, to the unaided eye, at 4,000 times its least dimensions; experiments seem to show that this is safe. Therefore, the greatest distance, L, at which a mark of width, w, will be visible through a telescope magnifying M times is

$$L = 4{,}000\ w\ M; \qquad (5)$$

and the length of rod, l, required for the sight, L, is determined by

$$l = L\frac{S}{D} = 4{,}000\ w\ M\frac{S}{D} = \mathrm{L}\frac{i}{f} \text{ very nearly,} \qquad (6)$$

in which D is the distance on the ground corresponding to the space, S, on the rod; $\frac{S}{D}$ is usually about

$$\frac{1}{100} \qquad (7)$$

Also the smallest difference in distance perceptible $= \frac{D}{S}d$, in which d is the value of the smallest division of the graduation. These formulas, together with a knowledge of the field of view, the magnifying power of the telescope, and the longest probable sight, are useful in determining the distance apart of the hairs and in graduating the rod.

10. Any self-reading leveling rod† can be used as a stadia rod; but it is best to omit the numbers, for it is easier to count the divisions included in the visual angle than to read both hairs and subtract. If the graduation of the rod consists of a great number of very small divisions, they become wholly indistinct at a distance greater than L as above, and at even shorter distances, it is very confusing to count them. Also, it is best to keep the colors as much together as possible, else when the air is unsteady the figures will run together to such an extent that it will be impossible to distinguish them. For these reasons, it is much better to make the graduation marks larger, and secure the smaller divisions by subdividing the larger ones by estimation; the rod can then be used at very great distances, although at a sacrifice of precision. This method by estimation is almost, or quite, as accurate as when the smaller divisions as marked; it is often claimed that very small subdivisions can be estimated more exactly than read by a direct graduation.

The adjoining figures show a few of the many forms proposed for stadia rods. Fig. 4 is a rod used on the U. S. Coast Survey; the vertical distance from a to b corresponds to 10 ft. on the ground from b to d = 4 ft., and by dividing bd into quarters by estimation, the rod may be read to single feet. The other designs are read in a similar manner. Fig. 5 was used on the late U. S. Lake Survey. The other figures are added to show the facility with which designs may be made. Nearly every one who uses a stadia, has a design of his own which he thinks is the best.

†For examples see ENGINEERING NEWS, Vol. 17, p.7-8.

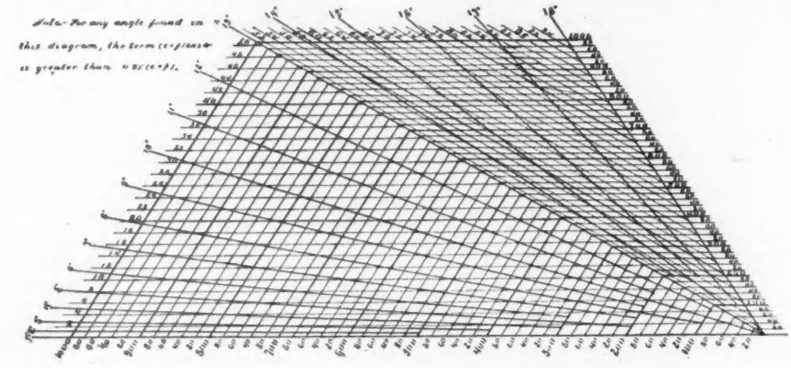


Plate 1.—Stadia Reduction Diagram for Horizontal Distances.
This diagram gives the term $R \sin.^2 \theta$. For any angle found, the term $(c + f) \cos. \theta$ is greater than $0.95\,(c + f.)$

11. POSITION OF ROD FOR INCLINED LINE OF SIGHT. Formulas (1) and (2) were deduced on the assumption that the central visual ray was horizontal and the rod vertical, but this is not sufficiently general. These formulas would be sufficient, if the observations were made with a leveling instrument, but the telescope of a level is too limited in its range to secure the full advantage of the principle of the stadia. In all that follows, it will be assumed that a transit is used.

Formula (3), $D = R + (f + c)$, may be used with an inclined line of sight, provided the rod is held perpendicular to the central visual ray; in this case D is no longer horizontal distance from the instrument to the rod; but is the oblique distance from the horizontal axis of the telescope to the point on the rod covered by the central visual ray. It then becomes a question whether, with an inclined line of sight, the rod should be held perpendicular to the central visual ray, or vertical.

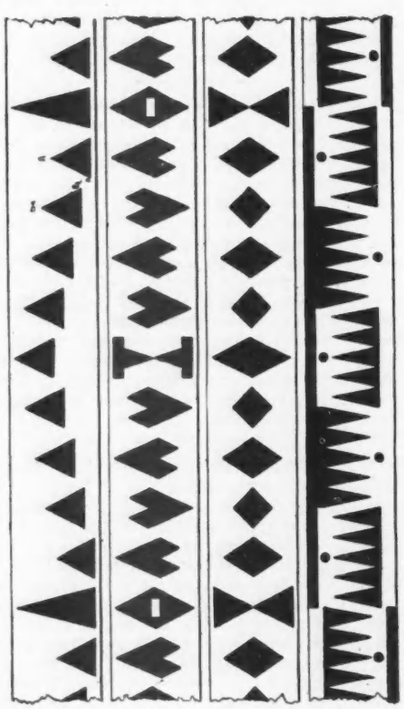


Fig. 4. Fig. 5. Fig. 6. Fig. 7.

The position of the rod perpendicular to the line of sight may be determined by a telescope, or a pair of sights, attached at right angles to the rod, which is directed toward the observing telescope by the rodman. The verticality of the rod may be determined by attaching a plumb-line or a level.

Some prefer the rod perpendicular to the line of sight, but this position involves serious difficulties; first, it is not easy to hold the rod steady in this position; second, it is not always possible for the rodman to see the telescope, especially at long distances or great vertical angles, or when undergrowth, etc., intervenes. Without going into the details it is sufficient to state that the formulas for computing the horizontal and vertical co-ordinates of the point are more simple when the rod is held vertical than when it is perpendicular to the line of sight.

FORMULAS FOR INCLINED LINE OF SIGHT AND VERTICAL ROD. Let θ = the angle of the central visual ray with the horizontal. To measure θ, a third horizontal hair should be placed half-way between the other two, or rather stadia hairs are to be added on opposite sides and equally distant from the ordinary horizontal one; θ is then determined as any other vertical angle by reading the vertical circle. θ will generally be small. Let 2α = the visual angle, = $B\,o\,D$, Fig. 8; 2α is always small, 35 may be taken

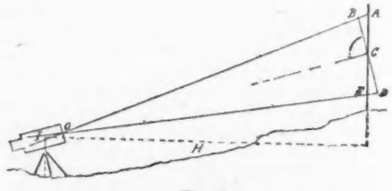


Fig. 8.

as its maximum value. $A\,E$ is the actual intercept, and $B\,D$ the value it would have if the rod were held perpendicular to the central visual ray. It is desired to find a relation between $A\,E$ and $B\,D$.

The angle $C\,B\,A = 90° + x$; and, since x is very small, $B\,C = A\,C \cos \theta$ nearly. Similarly $C\,D\,E = 90° - x$, and $C\,D = C\,E \cos \theta$. Hence $(A\,C + C\,E) \cos \theta = A\,E \cos \theta = B\,D$. Notice that the two approximations tend to neutralize each other; the final error involved is much less than the error of observing $A\,E$[2].

Since $B\,D$ is the intercept perpendicular to the line of sight, it is the rod reading corresponding to the distance $I\,C$. If we represent the reading on the vertical rod by R, we have for the oblique distance $I\,C$.

$$D = R \cos \theta + (f + c) \qquad (7)$$

13. HORIZONTAL DISTANCE. Let H = the horizontal distance from the center of the instrument to the vertical through the foot of the rod; $H = I\,P$, Fig. 8. $I\,P = I\,C \cos \theta = D \cos \theta$, and

$$H = R \cos^2 \theta + (c + f) \cos \theta \qquad (8)$$

$$\text{or } H = R - R \sin^2 \theta + (c + f) \cos \theta \qquad (8')$$

The second form is preferable, for it is always better to compute a correction to a quantity than

[2] If the side hairs are equally distant from the central one, the true relation is $B\,D = A\,E \cos \theta\,(1 - \tan^2 \theta \tan^2 d)$; and if the side hairs are not equally distant, the upper angle being x' and the lower, x the true relation is $A\,E = C\,B\dfrac{\cos x'}{\cos(\theta + \alpha')} + C\,D\dfrac{\cos x}{\cos(\theta - \alpha}$

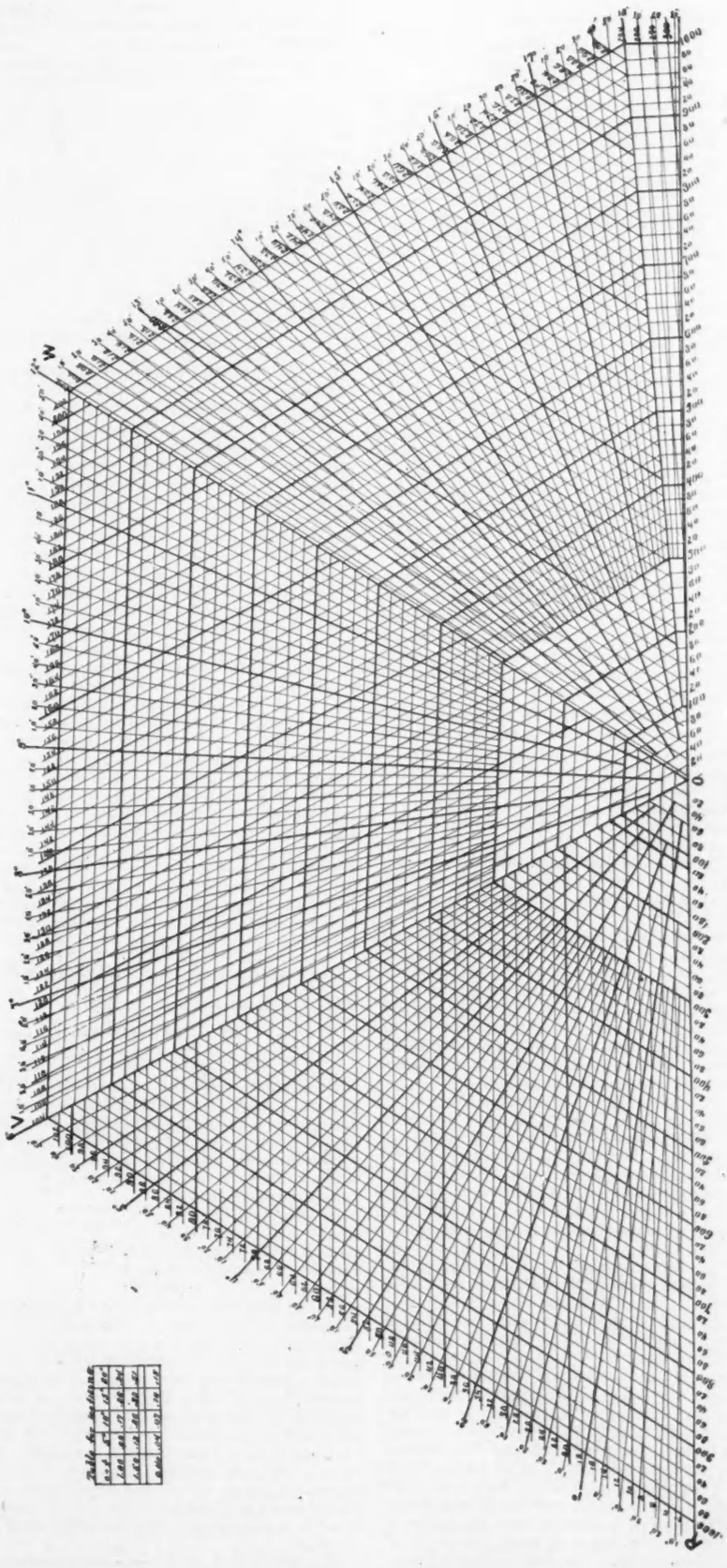


Plate 2.—Stadia Reduction Diagram.—This diagram gives the term $\frac{1}{2} R \sin. \theta$.

the quantity itself. Notice that since $(c + f)$ is always small, and $\cos \theta$ nearly 1, $(c + f) \cos \theta$ may always be taken equal to $(c + f)$, and often be omitted entirely. Finally, $\sin^2 \theta$ is so small tha the whole operation of reducing an observation by (8') may be performed mentally.

14. VERTICAL DISTANCE.—To determine the vertical co-ordinate of the point upon which the rod is set, the middle hair must be sighted upon a point of the rod at a known distance from its foot. The simplest way of accomplishing this is to provide the rod with a movable target, which is to be set at a distance from the foot of the rod equal to the height of the horizontal axis of the telescope above the reference point. If the instrument is set over the reference point, the target can easily be set by placing the rod at the side of the instrument; if the instrument is not over the point, set the rod on it, bring the line of sight horizontal, and sight the target in. To determine the height of any subsequent point, set the middle hair upon the target, and read the angle from the vertical circle. This method of pointing, besides being very simple in itself, very much simplifies the formula for the vertical co-ordinate.

Let V = the height of the point on which the rod is placed above the reference point; notice that for the above method of adjusting the target, V is equal to the distance of the target above the axis of the telescope. Then $C\ P$, the distance sought, $= V = I\ C \sin \theta$; substituting the value of $I\ C$ from (7)

$$V = R \cos \theta + (c + f) \sin \theta \qquad (9)$$

$$V = R \tfrac{1}{2} \sin 2\theta + (c + f) \sin \theta \qquad (9')$$

$(c + f) \sin \theta$ may generally be omitted. Notice that V will be + or −, according as θ is an angle of elevation or depression.

15. REDUCING THE FIELD NOTES.—This consists in finding the horizontal and vertical distance from the observed reading and angle of observation. This can be done by using formulas (8) and (9). Although the formulas are in a very convenient form for computation, it would be very tedious and slow to solve both equations for each obervation. It is a great saving of labor and time, if the results are computed once for all and tabulated.

Notice that $R \cos^2 \theta$ and $R \tfrac{1}{2} \sin 2\theta$ are independent of the instrument and of the unit of linear measurement used, and can be tabulated for all cases; $(c + f) \cos \theta$ and $(c + f) \sin \theta$ depend upon both the instrument and the unit, and must be computed for each special case, but as they are so small they can be given in a brief supplemental table.

The results may be expressed in an arithmetical table or a geometrical diagram.

Arithmetical tables are capable of greater accuracy; but they must be either very extended and therefore inconveniently large, or brief and give results by interpolation which is slow and tedious. On the other hand, it is urged against geometrical diagrams, that, to be accurate, they must be drawn to a large scale, and are therefore large and unwieldy. It is believed that, with properly constructed diagrams, the reductions can be made without sacrificing much, if any, accuracy and with greater facility than by the use of arithmetical tables.

In constructing a table, we may tabulate $R \cos^2 \theta$ from equation (8') and $R \tfrac{1}{2} \sin 2\theta$ from equation (9') for different values of R and θ, in which case the horizontal and vertical distances can be taken directly from the table; or, we may tabulate only $\cos^2 \theta$ and $\tfrac{1}{2} \sin 2\theta$ for different values of θ, in which case the horizontal and vertical distances are found by multiplying the reading R, by the tabulated factor. The first method would be the better, if it did not require such voluminous tables.

16. GEOMETRICAL TABLES.—There is a variety of methods of constructing diagrams for reduction of stadia observations, but as a modification of those proposed by Prof. S. W. ROBINSON[2] are believed to be the best they only will be explained.

17. DIAGRAM FOR VERTICAL DISTANCE.—We will employ equation (9,) and for the present consider only the term $R \tfrac{1}{2} \sin 2\theta$. Draw any line, as $O\ R$, Fig. 9, (Plate 2), and on it construct any scale of equal parts to represent the observed value of the

[2] Journal Franklin Institute, Vol. 49, pp. 80-1; and do. Vol. 51, pp. 15-6.

reading R; for convenience, we will assume 1,000 as the maximum value of R, which will be sufficient for most cases. Through the point R, drawn another line $R\,V$, making the angle $V\,R\,O$ about 60°; on this line lay off another scale of equal parts, making the unit of this scale, say, ten times, greater than that of $R\,O$. Put $R = 1{,}000$ and $\theta = 1°$ and compute the value of $R \frac{1}{2} \sin. 2\theta$; from the corresponding point of the scale of $R\,V$, draw a line to O, and mark it 1°, as in the diagram. In a similar manner, draw lines corresponding to $\theta = 2°, 3°, 4°$, etc., and such fractions of degrees as may be desired. Complete the diagram by drawing lines, parallel to $R\,O$, through the principal points of division of $R\,V$.

If the construction of the diagram, with the proportions as above, be continued much beyond 5° or 6°, the intersections will become too oblique for accuracy. This difficulty may be met by continuing the scale of $R\,V$ along $V\,W$, the angle $O\,V\,W$ being about 60°; the construction of the diagram is then continued as though $R\,V\,W$ were a straight line.[4]

This process may be continued until the probable maximum value of θ has been reached, or until the diagram completes the circle.

If the scale of $R\,V$ is made smaller, a greater number of degrees will be included, but the diagrams will be less accurate. For convenience in using the sections $V\,W$, etc., repeat the numbering of $R\,O$ along $V\,O$, $W\,O$, etc.

Concerning the second term of (5'), $(c+f) \sin. \theta$, we notice that it is always small and varies but slightly for a change of a whole degrees in θ; therefore calculate the values of $(c+f) \sin. \theta$, and place them in the supplemental tables; as on the diagram. For value of $(c+f)$ which differ from those given, the correction may easily be interpolated with ample accuracy. If the particular value of $(c+f)$ is known, the correction may be written outside of the diagram between the radii for the different degree.

To use this diagram, find on $O\,R$ the number corresponding to the reading of the stadia; then follow a line from this point parallel to $R\,V$ or $V\,W$, etc., until it intersects the line drawn from O, which represents the number of degrees in the observed vertical angle; then follow a line parallel to $O\,R$ or $O\,V$, etc., to the scale $R\,V\,W$; the intersection on this scale, plus the small correction $(c+f) \sin. \theta$, is the vertical co-ordinate sought.

18. DIAGRAM FOR HORIZONTAL DISTANCE.—It is best to use equation (4'), and find the correction, $R \sin.^2 \theta$, which is to be subtracted from R. The construction of the diagram for this case is similar to the previous one. The completed diagram is shown in Fig. 10, (Plate 1.) The correction, $R \sin.^2 \theta$, as found from this table is to be subtracted from R, and the term, $(c+f) \cos. \theta$, as found from the little table on the diagram, added, to obtain the required horizontal distance.

These diagrams are very carefully drawn, and can be used in reducing actual stadia readings.

19. SOURCES OF ERROR IN STADIA WORK.—Stadia work is subject to many of the errors discussed in the articles on the transit[5] and the level[6]; the additional errors peculiar to the stadia are, 1, inclination of the rod; 2, error in the value of $\frac{f}{i}$; and 3, error of observation.

INCLINATION OF ROD.—To investigate the effect of a slight inclination of the rod, let R = the reading when the rod is vertical; R' = the reading when the rod makes an angle v with the vertical. Then $R = R' \cos. v$ very nearly, and the error $= R - R' = R(1 - \cos. v) = R \sin.^2 \frac{v}{2} = \frac{R}{7000} v^2$, in which v is in degrees. Notice that the error increases as the square of the inclination, which shows the necessity of some means of plumbing the rod. Without some means of keeping the rod vertical, this would undoubtedly be the principal source of error in stadia work. On the U. S. Lake Survey, an inclined support was used to steady the rod and prevent its inclining to or from the instrument; a light tripod was also sometimes used for the same purpose.

VALUE OF $\frac{f}{i}$. If the value of $\frac{f}{i}$, or the corresponding unit on the rod, is not correctly determined, the results will be incorrect, although the relative position of points will be all right. The correct value of $\frac{f}{i}$ is easily found in the beginning, and with the methods of attaching the hairs described in Sec. 4, there is but little danger of its changing.

ERRORS OF OBSERVATIONS.—The principal item under this head is the inaccuracy in estimating the position of the hair on the rod; the amount of this error depends upon the size of the space on the rod, corresponding to a unit on the ground, and upon the form of graduation. For those rods with which the sides of the hairs are observed, this error is still further increased by the uncertainty due to the thickness of the hairs, and to any inequality in their thickness, as magnified by the eye-piece; this element of uncertainty does not exist with the graduations shown in Figs. 4-8.

Imperfect focusing, either of rod or hairs, is a source of error, because it is only when both are in focus at the same time that the assumed relations exist. If the rod is not in focus, the image covers too much space, which makes the distance too small. If the cross-hairs are not in focus, the distance will be read too small or too great according as the hairs are on one side or the other of the focus. If there is no parallax in the telescope, there will be no error from this cause.

The indistinctness of the image due to an unsteadiness of the atmosphere produces an error by making the image too large, and therefore, the distance too small. The only remedy is to wait for better atmospheric conditions.

Another somewhat common error is miscounting the reading so as to make errors of 10, 1000, etc.; feet. These errors may be prevented by care, or checked by double readings; or, instead of making an entirely new reading, the two halves of the visual angle may be read and their sum used to check the reading of the two outside hairs.

20. LIMITS OF PRECISION.—With reasonable care a high degree of accuracy can be attained in stadia measurement. The degree of precision is dependent upon the magnifying power of the telescope, the length of sight, and the ratio of the space on the rod to the corresponding space on the ground. It is sometimes claimed that stadia measurements are more accurate than chaining, but from the nature of the principles involved, it can not be so for equally favorable conditions; nevertheless, under many circumstances, the stadia is more accurate than chaining.

The following results seem to have been obtained with an ordinary engineer's transit; they are not selected, but are all the results of actual practice that could be found. In comparing results we must distinguish between the error of simply finding the distance by the stadia, and the final error of a series of courses, the lengths of which were determined by the stadia; the latter involves the error of measuring the angles as well as the distances.

To show the degree of precision obtained in measuring horizontal distance, we have the following: Three measurements, each of six distances, from 50 to 500 ft. made to test the accuracy of the stadia measurements,[7] the readings being made with targets, show an average probable error for a single sight of 1 in 4,000.[8] On the U. S. Lake Survey, three measurements of a base line, gave errors of 1 in 1,635 and 1 in 1888.[9]

Only the following can be found concerning the accuracy with which vertical distances can be determined. "Courses have been run one to six miles, over heights of 150 to 200 ft. in which the final error in height ranged from 0 to 1.5 feet, with no more than ordinary care."

Concerning the final error of a series of courses the lengths of which were determined by the stadia, we have the following: "The stadia was used for getting the topography of some densely wooded timber land in the summer of 1863. The courses were so run as to connect points of triangulation from 1 to 4 miles apart. The distances from point to point along the courses, ranged from 100 to 500 ft. The latitudes and departures were subsequently computed with the object of finding the error of stadia measurement. The results obtained were about 1 in 800, 1 in 1000, and 1 in 1100."[10] On the U. S. Lake Survey, in computing the co-ordinates of stadia work for 1875, the average amount discovered in 141 lines, varying between 3,200 ft. and 22,000 ft. (mean 8,080 ft.), when compared with lines determined by triangulation or chaining, was found to be 1 in 649; the maximum limit of error was put at 1 in 300.[11] In a survey of Red river, conducted by the U. S. Army Engineers and extending over about 70 miles, the stadia work and chaining were checked at 8 points along the line, and showed an average difference of 1 in 430.[12]

21. PRACTICAL HINTS.—The many advantages of stadia measurements in surveying need not be dwelt upon; they are self-evident to those acquainted with the principles. The general ease and quickness of telescopic measurement has always been recognized. In broken country, the stadia can be readily used where the use of the chain is not practicable at all. The stadia is specially applicable to topographical surveying, to the topographical work of a railroad survey, and to determining lengths of sights in leveling.

It could be profitably employed in ordinary land surveying; the trouble of training chainmen, or of trusting work to inexperienced chainman, would be avoided, and the delays of chaining would be saved. Instead of two chainmen only, one rodman is needed, and his duties are very simple; thus all the important work could be done by the surveyor himself. This would secure greater accuracy where most needed, in the measurement of the distances. It would require the substitution of a telescope for the ordinary compass-sights, or, better the employment of a transit instead of a compass, and the reading of the angles independent of the needle.

The stadia may also be used for under-ground surveying, where chaining is peculiarly disagreeable and difficult; in under-ground work a box lighted on the inside, with a glass front on which the graduation is painted, is substituted for the rod.[13]

22. To obviate the difficulty of estimating a fraction for both hairs, set one of them at the beginning of a division; this will produce a little error in the vertical co-ordinate, but generally so little as to be inappreciable. With long sights or small angles, it is still more convenient and also sufficiently accurate, to set one of the hairs upon one of the more prominent divisions; as the even foot mark, etc.; by remembering that each hair may be moved either of two ways and moving the telescope so as to produce the least displacement, this method of placing one of the hairs at an even division can frequently be used without any error, and thus greatly facilitate the work.

[4] This ingenious device was proposed by one of the author's students, Alonzo Courtney; Prof. Robinson meets the difficulty by constructing separate diagrams.

[5] ENGINEERING NEWS. Vol. 17, p. 305-6.

[6] ENGINEERING NEWS. Vol. 17, p. 197-9.

[7] Van Nostrand's Engineering Magazine. Vol. 30, p. 319

[8] Van Nostrand's Engineering Magazine. Vol. 30, p.476.

[9] Jour. Franklin Inst. Vol. 49, p. 74.

[10] Jour. Franklin Inst., Vol. 49, p. 74.

[11] Final Report U. S. Lake Survey, p 34.

[12] Report of Chief Engineer, U. S. A., 1873, p. 638.

[13] Jour. Franklin Inst., Vol. 55, pp. 394-7.

The Registry Bureau of Philadelphia, Pa.

Written for ENGINEERING NEWS

BY JOHN H. DYE, REGISTRAR.

Concluded from page 168.

It sometimes happens that after a large lot has been subdivided, say into 16 ft. lots, and each lot conveyed to a different person, before being built upon some one person will buy them all and arrange the subdivisions differently; say, instead of dividing 80 ft. into five 16 ft. lots, (and entered as Nos. 1, 2, 3, 4 and 5), he will make four 20 ft. lots. We enter the complication by giving new numbers to the last subdivision. (Nos. 6, 7, 8 and 9.) Upon the line of No. 1 we enter, *covered by No.* 6; upon the line of No. 2: *subdivided, see Nos.* 6 *and* 7, and rule it out by red line; upon line of No. 3: *subdivided, see Nos.* 7 *and* 8, and rule it out by red line; upon line of No. 4: *subdivided, see Nos.* 8 *and* 9, and rule it out by red line; and upon line of No. 5: *covered by No.* 9. This, it will be seen, preserves a record of the whole transaction. To keep the number of such complications to a minimum, we make it a rule not to enter subdivisions in the name of *one person*, until the descriptions indicate that lines have been fixed by the erection of buildings; even though the subdivisions have been made by separate deeds, it is always entered as one lot covering the full front.

16	16	16	16	16
1	2	3	4	5
20	20	20	20	
6	7	8	9	

Where transmission of title takes place by will, the description is copied from the last deed, or if an estate has been divided,—from the deed of partition; the name of the present owner being the devisee, and the former owner the testator; if by will, the date of the probate of will is given in lieu of deed—that of course being the date of actual transfer. When parties take title by descent, we enter in column of "*Date of Deed*" *by descent.*

It will be understood that the description of a transfer should give the name of the *Former Owner* to agree with the name of the *Present Owner* as already entered; if they should not agree there is evidently a transfer missing, and we immediately make an examination to find it, to make the chain of title complete. It is usually found to be a transfer by will or by descent, and we enter the missing link in red ink.

The most troublesome transfers would appear to be from Sheriff's Sales. Frequently in the report from such deeds the name of the former owner agrees with a name entered many years previously, and the lot, in the interval, may have been transferred several times. This may be easily accounted for, as the sale may be the foreclosure of a mortgage or for arrears of ground rent, which must be in the name of the original covenantor. But when a persons' *supposed* interest in a lot is sold, his name not appearing in any part of the chain of title, and he possibly having no interest in it, then we enter it in the name as reported and say, *as of (John Smith) by Sheriff*, to show that the title does not connect, and to put all parties on their guard as to the title, since we, of course, have no authority to examine into nor to decide questions of title.

The following, though somewhat lengthy, gives the form of the official records as taken from the Plan, Fig. 2, and the transfers, etc., indicated on Fig. 3:—

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Barnaby Rudge.	Wm. Penn.	Jan. 4, 1846.	—

All that certain lot or piece of ground, beginning at the northeasterly corner of Morris and Tenth streets, thence extending N. 11°.21.' E., along the east side of Tenth street 195 ft. and ¼ in. to a point, thence N. 50.°49' E. 265 ft. 5½ in. to the south side of Franklin street, thence S. 78°.39' E. along the south side of Franklin street, 131 ft. 3 in. to the west side of Ninth street, thence S. 11°.21' W., along the west side of Ninth street, 400 ft. to the north side of the said Morris street, and thence N. 78°.39' W., along the north side of said Morris street, 300 ft. to the east side of Tenth street and place of beginning.

(*Endorsed.*) BARNABY RUDGE.
Entered January 5, 1880.
Lot No. 1.
PLAN BOOK No. 8. Page 6.
No. — Morris street.
FIRST WARD.
DIVISION No. 5.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Benj. Eastburn.	John Penn.	April 16, 1832.	—

All that certain lot or piece of ground, beginning at the southeasterly corner of Frankin and Tenth streets, thence extending S. 78°.39' E., along the south side of Franklin street, 165 ft. 9 in. to a point, thence S. 50°.49'W. 55 ft. 9 in. to a corner, thence N. 39°.11' W. 90 ft. 4¼ in. to the east side of said Tenth street, and thence N. 11°.21' E., along the east side of said Tenth street 62 ft. 9¾ in. to the south side of said Franklin street and place of beginning.

(*Endorsed.*) BENJAMIN EASTBURN.
Entered, January 20, 1880,
Lot No, (2).
PLAN BOOK No. 8. Page 6.
No. — Franklin street.
FIRST WARD.
DIVISION, No. 5.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Mark Twain.	Pilot Brown.	By Descent.	—

All that certain triangular lot or piece of ground, beginning at a point on the easterly side of Tenth street, at the distance of 62 ft. 9¾ in. southward from the south side of Franklin street, thence extending S. 78°.39' E. along the south side of Franklin street, 165 ft. 9 in. to a point, thence S. 50°.49' W. 55 ft. 9 in. to a corner, thence N. 39°.11' W. 90 ft. 4¼ in. to the east side of said Tenth street, and thence N. 11°.21' E. along the east side of said Tenth street, 142 ft. 1¾ in. to the place of beginning.

(*Endorsed.*) MARK TWAIN.
Entered, April 5, 1880.
Lot. No. (3.)
PLAN BOOK No. 8. Page 6.
No. — Tenth street.
FIRST WARD.
DIVISION, No. 5.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Mulberry Sellers	Mark Twain.	Sept. 9, 1880.	—

All that certain triangular lot or piece of ground beginning at a point on the easterly side of Tenth street, at the distance of 62 ft. 9¾ in. southward from the south side of Franklin street, thence extending S. 39°.11' E. 90 ft. 4¼ in. to a corner, thence S. 50°.49' W., 109 ft. 8½ in. to the east side of said Tenth street, thence N. 11°.21' E., along the east side of said Tenth street, 142 ft. 1¾ in. to the place of beginning.

(*Endorsed.*) MULBERRY SELLERS.
Entered, Sept. 9, 1880.
Lot No. (3.)
PLAN BOOK No. 8. Page 6.
No. — Tenth street.
FIRST WARD.
DIVISION, No. 5.
(*Transfer.*)

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Mulberry Sellers	Benj. Eastburn	Oct. 8, 1880.	—

All that certain lot or piece of ground, beginning at the southeasterly corner of Franklin and Tenth streets, thence extending S. 78°.39' E. along the south side of Franklin street, 168 ft. 9 in. to a point, thence S. 50°.49' W., 165 ft. 9 in. to a corner, thence N. 39.°11' W. 90 ft., 4¼ in. to the east side of said Tenth street, and thence N. 11°.21' E. along the east side of said Tenth street 62 ft. 9¾ in. to the south side of said Franklin street and place of beginning.

(*Endorsed.*) MULBERRY SELLERS.
Entered, October 16, 1880.
Lot. No. (2.)
PLAN BOOK No. 8. Page 6.
No. — Franklin street.
FIRST WARD.
DIVISION, No. 5.
(*Transfer.*)

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Barnaby Rudge	Mulb'y Sellers.	March 1, 1881.	—

All that certain triangular lot or piece of ground, beginning at a point on the southerly side of Franklin street, at the distance of 119 ft. 4½ in. eastward from the east side of Tenth street, thence extending S. 78°.39' E. along the south side of said Franklin street 49 ft. 4½ in. to a point, thence S. 50°.49' W, 77 ft. 8½ in. to a point, thence N.11°.21' E., 60 ft. to the south side of said Franklin street, and place of beginning.

(*Endorsed.*) BARNABY RUDGE.
Entered, March 1, 1881.
Lot No. (4).
PLAN BOOK No. 8. Page 6.
No. — Franklin street.
FIRST WARD.
DIVISION, No. 5.
Subdivision of No. 2.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Mulb'y Sellers.	Barnaby Rudge.	March 1, 1881.	—

All that certain triangular lot or piece of ground, situate on the north side of a certain 40 ft. wide street laid out and intended to be opened as a public highway, extending from Ninth street to Tenth street, parallel with and at the distance of 180 ft. southward from Franklin street, to be called Union street; beginning at the distance of 20 ft. 6½ in. eastward from the east side of Tenth street, thence extending S. 78°.39' E., along the north side of said Union street, 98 ft. 9¾ in. to a point, thence N. 11°.21' E., 120 ft. to a point, thence S. 50°.49' W., 155 ft. 5¼ in. to the north side of said Union street and place of beginning.

(*Endorsed.*) MULBERRY SELLERS.
Entered March 1, 1881.
Lot No. 5.
PLAN BOOK No. 8. Page 6.
No.—Union street.
FIRST WARD.
DIVISION No. 5.
Subdivision of No. 1.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Paul Dombey.	Mulb'y Sellers.	April 6, 1882.	1609.

All that certain lot or piece of ground situate on the easterly side of Tenth street, at the distance of 80 ft. southward from the south side of Franklin street, containing in front or breadth on the said Tenth street 20 ft. and extending in length or depth eastward parallel with said Franklin street, 119 ft. 4½ in.

(*Endorsed.*) PAUL DOMBEY.
Entered April 7, 1882.
Lot No. 6.
PLAN BOOK No. 8. Page 6.
No. 1609 Tenth street.
FIRST WARD.
DIVISION No. 5.
Subdivision of Nos. 2, 3, & 5.

Present Owner	*Former Owner.*	*Date of Deed.*	*House No.*
Sam'l Weller.	Mulb'y Sellers. (By Sheriff.)	July 1, 1882.	1601.

All those four several lots or pieces of ground with the buildings thereon erected, situate on the southeasterly corner of Tenth and Franklin streets, containing together in front or breadth on the said Tenth street 81 feet, (each lot being 20 ft.) and extending in length or depth eastward parallel with, and along the south side of said Franklin street, 119 ft. 4½ in.

(*Endorsed.*) SAM'L WELLER.
Entered July 2, 1882.
Lot Nos. 7, 8, 9 and 10.
PLAN BOOK No. 8. Page 6.
Nos. 1601, 3, 5, 7 Tenth street.
FIRST WARD.
DIVISION No. 5.
Nos. 7, 8 and 9, Subdivisions of No. 2.
No. 10, " " 2, 3 and 5.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Mark Tapley.	Mulb'y Sellers.	Aug. 15, 1882.	1611.

All those four contiguous lots or pieces of ground with the buildings thereon erected, situate on the easterly side of Tenth street, and northerly side of Union street, containing together in front or breadth on the said Tenth street 80 ft (each lot being 20 ft.) and extending in length or depth eastward, parallel with and along the north side of said Union street 119 ft. 4½ in.

(*Endorsed.*) MARK TAPLEY.
Entered August 15, 1882.
Lots. Nos. 11, 12, 13 and 14.
PLAN BOOK No. 8. Page 6.
Nos. 1611, 13, 15, and 17 Tenth street.
FIRST WARD
DIVISION No. 5.
No. 11, Subdivision of Nos. 2, 3 and 5.
Nos. 12, 13 and 14. " " " 3 and 5.

Present Owner.	*Former Owner.*	*Date of Deed.*	*House No.*
Oliver Twist.	Mark Tapley	Nov. 23, 1882.	1611.

All that certain lot or piece of ground with the buildings thereon erected, situate on the easterly side of Tenth street at the distance of 100 ft. southward from the south side of Franklin street, containing in front or breadth on the said Tenth street, 20 ft. and extending in length or depth eastward parallel with the said Franklin street 119 ft. 4½ in.

(*Endorsed.*) OLIVER TWIST.
Entered November 23, 1882.
Lot No. 11.
PLAN BOOK No. 8. Page 6.
No. 1611 Tenth street.
FIRST WARD.
DIVISION No. 5.
(*Transfer.*)

	ORIGINAL ENTRY.							TRANSFERS.			
No.	Entered.	Owner.	Date of Deed.	No. of House.	Street.	Feet Front.	Former Owner.	Owner.	Date of Deed.	Owner.	Date of Deed.
1	Jan. 5, 1880.	Barnaby Rudge.	Jan. 4, 1846.		Morris.	300	William Penn.	Subdivided see	Nos. 5.		
2	Jan. 20, 1880.	Benj. Eastburn.	April 16, 1832.		Franklin.	168·9	John Penn.	Mulberry Sellers.	Oct. 15, 1880.	Sub. see Nos. 4,	6, 7, 8, 9, 10, 11
3	April 5, 1880.	Mark Twain.	By descent.		Tenth.	142·1¾	Pilot Brown.	Mulberry Sellers.	Sept. 9, 1880.	Sub. see Nos. 6,	10, 11, 12, 13, 14
4	March 1, 1881.	Barnaby Rudge.	March 1, 1881.		Franklin.	49·4½	Mulberry Sellers.	"	"		
5	Mar h 1, 1881.	Mulberry Sellers	March 1, 1881.		Union.	98·9¾	Barnaby Rudge.		Sub. see Nos.	6, 10, 11, 12, 13, 14	
6	April 7, 1882.	Paul Dombey.	April 6, 1882.	1609	Tenth.	20	Mulberry Sellers.				
7	July 2, 1882.	Samuel Weller.	July 1, 1882.	1601	"	"	Mulberry Sellers, by Sheriff.				
8	July 2, 1882.	Samuel Weller.	" "	1603	"	"	"				
9	July 2, 1882.	Samuel Weller.	" "	1605	"	"	"				
10	July 2, 1882.	Samuel Weller.	" "	1607	"	"	"				
11	Aug. 15, 1882.	Mark Tapley.	Aug. 15, 1882.	1611	"	"	Mulberry Sellers.	Oliver Twist.	Nov. 23, 1882.		
12	Aug. 15, 1882.	Mark Tapley.	" "	1613	"	"	"				
13	Aug. 15, 1882.	Mark Tapley.	" "	1615	"	"	"				
14	Aug. 15, 1882.	Mark Tapley.	" "	1617	"	"	"				

Fig. 3.

Cincinnati, O.—Early this month there was much anxiety caused by the high stage of water in the river, which submerged the pumps so that no repairs could be made in case of accident; they had been under water for about a month. On the 7th inst. the pump well was pumped out, a dangerous proceeding in consequence of the great pressure due to the high water. In a communication to the Board of Public Affairs, ARTHUR G. MOORE, Superintendent and Engineer, stated that: "the present emergency in the main pumping service is an evidence of the want of margin in its capacity, and especially so when it is rendered inaccessible by continuous high water in the river. Except the placing of the non-effective Wetherill engines by the last board, there has been no increase of this pumping power since thirteen years ago, when the maximum daily consumption was about 18,000,000 gallons. As the largest daily consumption in 1886 was over 38,000,000, it is apparent that the demands upon the old power has increased over 100 per cent." He recommends the purchase of new plant, with a daily capacity of 25,000,000 gallons, to supersede the old combination engines, which are both worn out and of small capacity. A bill for this purpose has been endorsed by the Board; the expense being limited to $160,000.

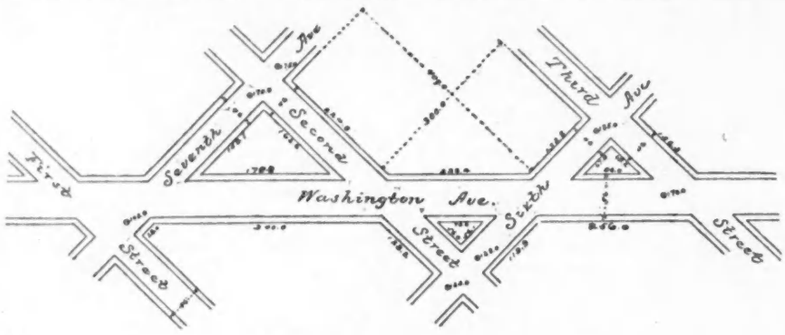
CORRESPONDENCE.

Street Grade Intersections.

DULUTH, Minn., March 8, 1887.

EDITOR ENGINEERING NEWS:

I have read with much interest the article in a recent number of ENGINEERING NEWS about street intersections, and would like to ask your readers the best solution of the following problem: Required the grade elevations on all curb and property intersections of Second street and Washington avenue, making the grades of the other streets and avenues the best possible. The elevations at the points shown in sketch are fixed and the property owners insist on the grades being established. Included in this problem is the question of the greatest inclination allowable in the cross-section of a side-hill street.



A Problem in Street Intersections.

A READER.

Mr. Wm. Griswold.

MADISON, IND., March 12, 1867.

EDITOR ENGINEERING NEWS:—

Can you tell me where WM. GRISWOLD is; the engineer that printed an engineering field-book in 1854? I would like to know if he is still living and his address if alive.

Yours truly,
C. A. GORDON.

The Form of the Under Side of Rail Heads.

Office of Engineer and Road Master in Chief,
Providence & Worcester R. R.
WOONSOCKET, R. I., March 4, 1887.

EDITOR ENGINEERING NEWS:

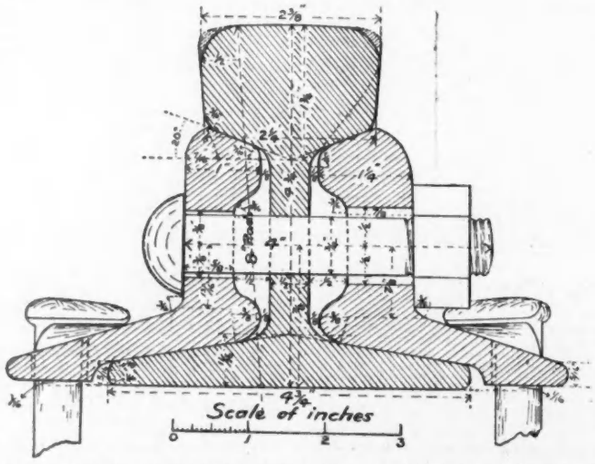
In your issue of Feb. 26, under the article "Form of the Under Side of Rail Heads," the conclusion was "Fig. 9 represents a far better type for rail wear apart from the joints, as is thought to have been made clear; also "that the metal marked *a* in Fig. 8 is in every sense of the word base metal," etc. Is not the 72 lbs. rail section adopted by the Providence & Worcester Railroad in 1885 a compromise between the Pear shaped head "Fig. 9" and the Lehigh Valley "Fig. 4"? A blue print of the same is sent you, and of the angle bars therefore.

I wished to have as strong and stiff a rail, using angle-bars for the joint, as I could get from a 72 lb. section, and by making the head of a somewhat pear shaped form, taking away the metal wherever I could, and not decreasing its strength so as to increase its head, to get as much life from the rail as possible. Please notice that with height 4¾ and base 4⅜ in., the head of the rail has ⅛-in. more width at top than at bottom with a 20° fishing angle (so called) and the web of rail has ½-in. thickness of for most its height, by which some of the metal was taken away to help the wearing part of its head: The thickness of the base is $\frac{7}{16}$-in. at its edge, and as square at the corners as they could roll it to advantage, so as to help the life of the spike and not let it be cut into, as most rail sections will do, that have their sharp edges at their base.

I laid some of this rail in November, 1885, where the ballast is of sand and road bed in poor condition, with 80 daily trains or engines over the track, and can say, thus far, that no angle bars nor bolts have broken and none are loose to cripple the rail at joint (no nut lock being used with the common, Hoopes & Townsend make bolt and nut in use) which I think is owing to the fit of the angle bar to the rail, when screwed up tight, there being ⅛-in. space between web of rail and nearest parts of angle bar. I know roadmasters are against the 20° fishing angle, yet with the ¼-in. radius at corner where web and head of railroad meet, I have at least ⅝-in. bearing surface for my angle bar, which is more than some other 72lb. sections with 14° fishing angle have.

As a roadmaster, I believe in the radius of ½-in. at corner of head of rail instead of ¼-in., advocated by some, on account of not wishing to see wheels with the metal "B Fig. 12" removed from same, running through my frogs and guard rails. The head of our rail will not make the flange of such sharp badly worn car-wheels worse, or help such car wheels to be dangerous by climbing the rail on the numerous curves of this road. The angle bars in use weigh 44 lbs. per pair, and are 23-in. long, and are somewhat similar in shape to the Lehigh Valley bars. I laid, last August, at South Worcester, on the main track a 7½° curve, 3½-in. elevator, guage 4 ft. 8½-in. with this rail bolted to new 7-in. chestnut and oak ties, with the Bush interlocking bolt and nut, which is at the end of a freight yard, where the switch engines use it considerably in their work, and shall endeavor to get statistics to compare with other 72 lb. rail sections of different form. As there is a tendency to increase the weight of the rail very much more than to 72 lb. per yd. does it pay so to do? Will not American steel rail on a double track road, with heavy traffic, become crippled or smashed down in its head at the joints, requiring the expense of a saw to cut off the poor end and thus reduce the length of the rail so as not to get the proper life of the amount of steel in section used even with a 72 lb. section? As the base of a section of rail should be as wide as its height will there not be more chance for flaws in the base of the rail while rolling in such heavy sections, that will not appear until in use?

Yours truly,
WILLIAM F. ELLIS,
Chief Engineer, P. & W. R. R.



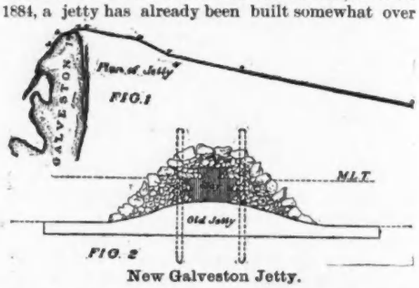
Standard Rail-section, Providence and Worcester Railroad—72 lbs. per yard.

[The metal noted in dotted lines on the corner, was put on for illustration proposes, as also the dotted line in the head, and do not belong to the original drawing. Ed.]

[The HOOPES & TOWNSEND bolts and nuts are not "common" ones, but very uncommon ones, specially cut to fit accurately together and dispense with all need of a nutlock. As to the radius of the corner of the rail will our correspondent oblige us by sending us the evidence on which he concludes that the metal which we have added on the corner of his section does in fact cause wheels to wear sharp of flange? We apprehend he will have some trouble in doing so, and if he assumes it to be self-evident we fear he is going far beyond what the facts will warrant. But the main features of his section seem to us very good, as we noted last week.—ED. ENG. NEWS.]

Jetty at Entrance to Galveston Harbor, Texas.

The sketch given herewith shows the plan and cross-section of the new jetty extension at Galveston Harbor. As shown in ENGINEERING NEWS, Nov. 29, 1884, a jetty has already been built somewhat over four miles from Fort Point with mattrasses; for the first 1,000 ft., the average crest of this old jetty is about 2 ft. above mean low water; for the next 2 miles it is about 4 ft. below mean low water, and for the outer 2 miles it is 6 ft. below low water.



New Galveston Jetty.

Maj. O. H. ERNST, U. S. Engineers, now proposes to build up the first two miles of this jetty to a height of 5 ft. above mean low water in the manner shown in Fig. 2. In building this, from *A* to *B*, Fig. 1, ordinary riprap will be used in raising it to the height required. From *B* to a point about 2 miles out the jetty will have the cross-section shown in Fig. 2. Two rows of piles will be driven 5 ft. 6 in. each side of center-line of jetty; riprap will then be deposited outside to a height of 2 ft. and the space between filled with clay; then riprap 2 ft. deep is again put on and filled as before until a height of 2 ft. above low water is reached, and above this point the jetty will be wholly of stone with the top and outer slopes protected by blocks weighing not less than one ton each. The width on top will be 12 ft., side slopes 1 to 1, and clay core about 8 ft. thick.

Sealed proposals for this work will be received until 12 M. April 16, 1887, at the U. S. Engineer's office, Galveston, Texas, the amount of money avail-

able being $280,000. The approximate quantities assumed are:—41,500 cu. yds. ordinary riprap; 36,600 cu. yds. stone blocks of 1 to 2 tons each; 16,300 cu. yds. of clay. The bids must be for each item. Work must be commenced by June 1 and completed by March 1, 1888.

The Interchange of Water Between the Black Sea and the Mediterranean.

This question has been a subject of study since 1681. Lately Capt. MARAKOFF, of the Russian navy has been conducting careful experiments for the purpose of testing the temperature of the water, its specific gravity, and the velocity at various depths. His general conclusions are as follows:—The water of the Mediterranean is heavy (specific gravity 1.030) and warm, being between 55° and 80° Fahr., and at a constant temperature of 55° F. 200 fathoms down. The waters of the Black Sea are light (gravity 1.013 to 1.016) and compraatively cold, the summer temperature below 80 fathoms, being constant at 50° F.; while at the surface it rises to 77° in summer, and sinks to 42.8° F. in winter; the level of surface owing to the excess of river flow over evaporation and lower specific gravity is higher than that of the Mediterranean.

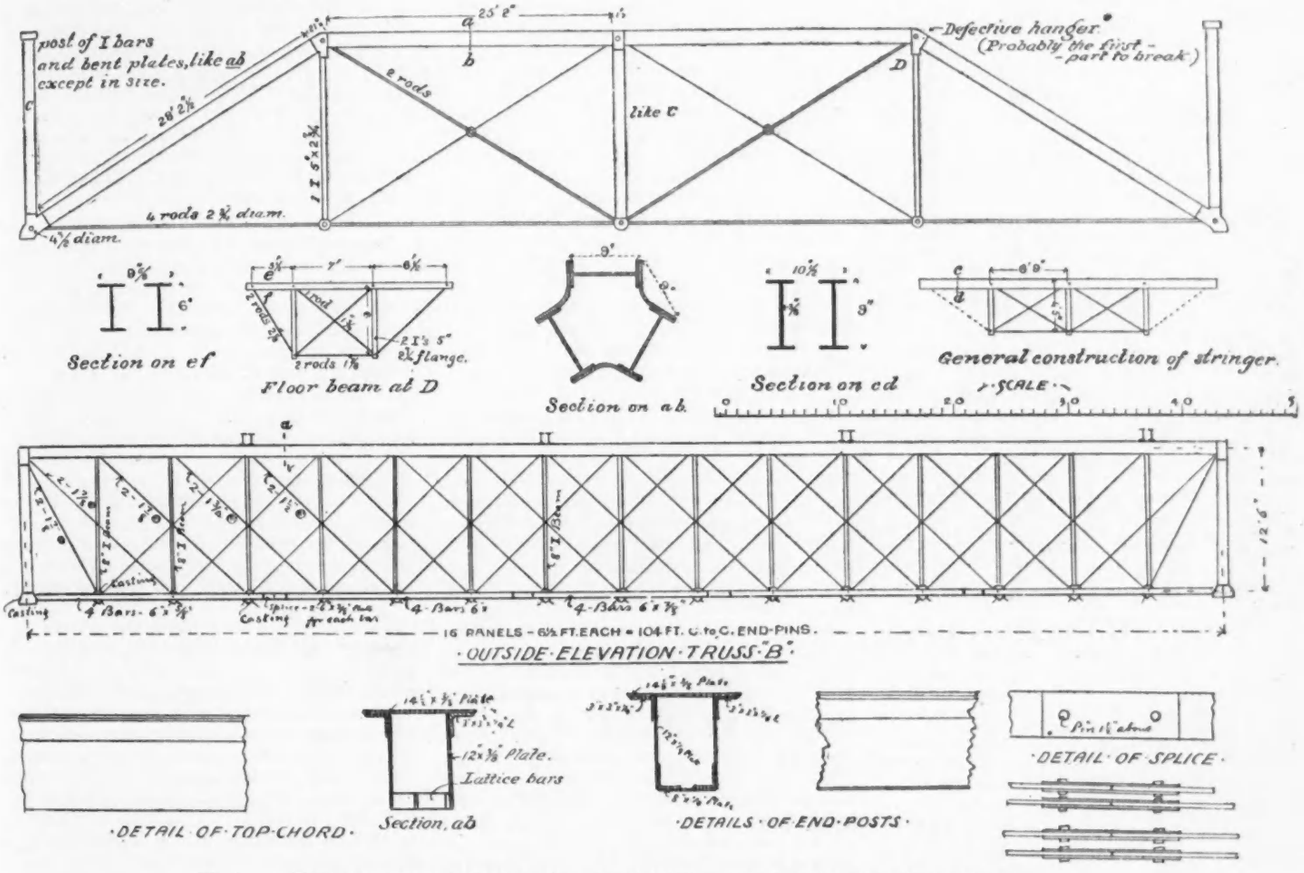
The water of the Mediterranean penetrates into the Sea of Marmora by an under current reaching from 6 fathoms below the surface to the bottom while a current in the opposite direction sets along the surface. This boundary between the currents gradually sinks from 6 fathoms in the Straits to 10 fathoms below in the Sea of Marmora. Two currents also exist in the Bosphorus; a lower one of comparatively heavy and warm water sets in towards the Black Sea, and a light and cold current setting out on top. The boundary between these currents sinks from 10 fathoms, opposite Constantinople, to 27 fathoms at the entrance to the Black Sea. No trustworthy calculations have been yet possible as to the volume of water passing, though the velocity has been found to vary from 1 to 2.38 knots per hour.

ENGINEER WHITE says of the accident:

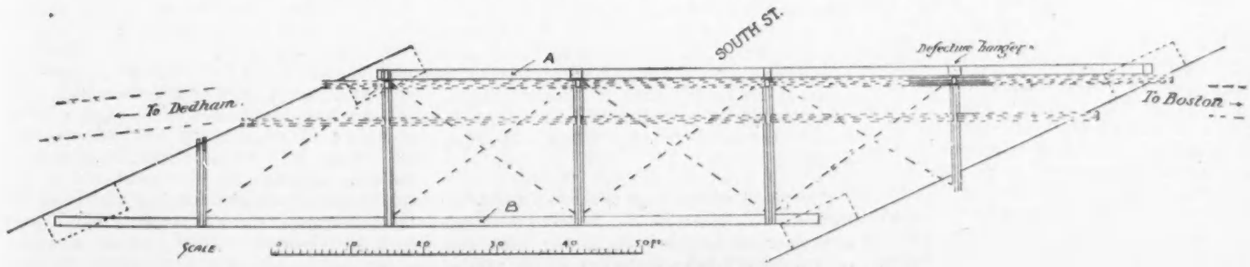
"The engine and tender had passed when I looked backward at the cars behind me. What the cause of that glance was I can never explain. It was urged to from some unseen source, and then again I was not. One looks more naturally forward than behind and at this juncture particularly the look may have been suggestive. However, as I cast a glance at the train behind, I *saw the first car swing upward and topple over* as though about to fall, and while I still looked amazed and bewildered, the *second and the third cars* tipped over in similar positions and *all finally jumped the track*. The engine kept to the rails, however. I turned for a moment to slack my engine, and when I turned back, of the nine cars but three remained in sight.

When I saw what fatality had befallen us, I made instant start for relief. With the concussion of the shock, or of the cars leaving the track, the coupling pin attaching the engine to the first car snapped and we were free. With all steam on and with the throttle wide open we started for relief.

The real cause of the mysterious impulse to look backward which ENGINEER WHITE could not explain was probably the shock of the first breakage which barely shook the engine a little.


post of I bars and bent plates, like ab except in size.
Defective hanger.* (Probably the first part to break.)
2 rods
like C
4 rods 2¾ diam.
4⅞ diam.
Section on ef
Floor beam at D
Section on ab
Section on cd
General construction of stringer.
SCALE
OUTSIDE ELEVATION TRUSS "B"
16 PANELS - 6½ FT. EACH = 104 FT. C. to C. END-PINS.
DETAIL OF TOP CHORD.
Section, ab
DETAILS OF END-POSTS.
DETAIL OF SPLICE.

*The two hangers at this point are the ones whose broken sections are shown by full scale drawings.



Plan and Elevation of the Wrecked Trusses of the Bussey Bridge.

[Made from Sketches and Measurements taken on the ground after the Wreck, and defective in showing the position of the floor beams on the older truss, *B*, which should be one panel further to the right.]

E. G. WATSON, Editor *Mechanical Engineer*, says that the welding of copper, referred to in our last issue, is no new thing. He says he welded copper rods 10 years ago by melting concentrated lye in an iron pot over the fire, and when the water of crystallization was driven off, and while the mass was in a pasty state, diping the scarfed ends of the hot copper into this as a flux and welding with a hammer.

MAYOR HEWITT approves of grooved rails on the Broadway horse-car line in this city, as interfering less with traffic than the present section. Rumor has it that the company may be forced to make the change; and a blessed good thing it would be too.

ENGINEERING NEWS
AND
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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.
GEO. H. FROST, - - - BUSINESS MANAGER.

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WHEN the first report of the catastrophe on the Boston & Providence reached this city, we telegraphed to various engineers to procure for us all information possible, and much information thus obtained appears in this issue. To make assurance doubly sure, however, we engaged Mr. HENRY S. PRITCHARD, a practical bridge engineer and experienced bridge inspector, to go to Boston and critically examine the structure in our behalf. He reached the ground 27 hours after the accident, found that the fragments of the wreck were being rapidly removed by a large gang of men; spotted at once the broken hangers as the probable cause of the disaster; noted that they still lay neglected at the point where they first fell; noted also that they had begun to rust badly by a day's exposure in clear weather, and that snow was coming on which might destroy their value as evidence; noted also that they might be scrapped with the rest of the wreck; asked a workman to knock them free for him with his sledge, which he did; carried off his relics with a long string of other relic hunters to the nearest express office, and expressed them to this journal, all within an hour.

In so doing Mr. PRITCHARD rendered the public as well as this journal a great service, and showed the intimate knowledge of bridge construction for which we gave him credit in engaging him. If any one before him had appreciated the vital importance of these fragments as evidence, as probably it will soon appear that many did, they took a singular and reprehensible way of showing it, in leaving them to lie neglected on the ground, to be tramped on by the curious, and sledged by ignorant workmen, as well as injured by the weather. The least they should have done was to stand guard over them until they were removed to a place of safety, for their importance lay even less in their wretchedly defective character, which indicated that they *might* have caused the disaster, than in their being the one part of the bridge which could have broken *and caused the precise sequence of events which followed*, as we have endeavored to make clear elsewhere.

It has appeared to us necessary to explain that these pieces came into our possession in no improper or under-handed or clandestine way, but solely through the neglect of others to take proper precaution, from the fact that a despatch came to our office from Boston the next day, worded as follows:

"* * * having authority, says that if broken pieces are sent at once to the Superintendent of the Providence Railroad, no remarks will be made."

The implication of these concluding words, which may break out anew in the investigation, is a false one; and we have only to add to the preceding that anyone is at liberty to make any remarks they please, and ENGINEERING NEWS will exercise the same privilege.

The cause of this dreadful catastrophe has been very obscure in the newspaper accounts, the only certain thing having been that the bridge was a sort of patch-work nondescript, which violated several of the most important and fundamental requirements of good bridge designing. We are now fortunately able to shed far more light on what the precise cause was, than has heretofore appeared, or than is at all likely to appear from any other source, even in the official investigation, from the fact that we have now in our office what will probably be the most important bit of evidence in that investigation, viz., the two original parts which in all human probability were the first to break. These parts are now in the possession of Mr. HENRY S. PRITCHARD, C. E., a practical bridge engineer, of Philadelphia, who undertook to critically examine the structure on behalf of this journal, and who went about it, apparently, a little more systematically than some who had preceded him. In connection with further information gathered for us, within an hour or two after the accident occurred, by Mr. FREDERICK BROOKS, C. E., of Boston, these fragments may be said to be absolutely conclusive as to the real difficulty, since it appears impossible that there should have been a more defective part in the bridge if it was to stand up at all.

The parts which first broke were the two hangers which carried the last or most easterly pair of floor-beams of the northerly or last built truss; the truss which carried nearly all the load. So far as can be judged from outside appearances, they are made of far from good iron to begin with, but in addition to that they are of very bad design and most imperfectly welded. In addition to that again, they are BOTH of them very badly flawed by old and deeply rusted breaks at the most strained section, there being two distinct breaks of this kind to each specimen. The first hanger has both breaks across the weld, the first break being complete and the second break, an inch and an eighth above it, all but complete, the metal merely hanging together by the outside skin. This hanger can never have done any work since its original and more ancient fracture or it would have broken apart long since.

The second hanger was checked across half its inside face (covered by the supposed weld) for about half its depth of effective section, and this was clearly where fracture first began. It caused a secondary fracture at a second old break in the hook of the welded end, which cut off a somewhat larger proportion of the effective strength of the iron.

All this is clearly shown in the engravings of the bridge and its broken parts which we publish, and the general judgment of engineers will bear us out in saying that more shamefully bad specimens of bridge design, metal, and workmanship can hardly exist. We regret to have to express so sweeping a condemnation of the structure, but the facts more than justify it, and it is but right that in an occurrence of this kind the truth should be pointed out and made clear, without fear or favor. It is appalling to think of the tens of thousands of lives which have literally hung by a thread in passing over this bridge during the past eleven years.

THAT the Forest Hill catastrophe did not become the most appalling on record, by the added horrors of an *auto da fé* to those of the wreck proper, was due only to three fortunate chances: *First*, telescoping of the cars which will smash anything in the form of a stove which the hand of man can fashion, of reasonable weight to be carried in the cars, did not chance to occur. Telescoping may occur in wrecks of this kind as well as in collisions, but it did not chance to. *Secondly*, the fall was not quite as great as at Ashtabula or Woodstock, and the breakage did not happen to come in such a way as to utterly wreck any even of the wretched stoves with which the cars were provided, so that the breaking out of fire was postponed until:—*Thirdly*, and chiefly, a chemical engine was able to put out the fire which did at last break out, in its incipiency; and this because the bridge chanced to be almost in the heart of a great city, in which respect it was one out of a hundred.

But for this last fact the two first mentioned bits of good fortune could hardly have been of much avail, and Ashtabula might have been far outdone. But while this almost marvellous exemption will naturally lead to a subordination of the question of car heating to the other lessons of the disaster, those most interested in averting such disasters will hardly do so, but will add this last wreck to the many other evidences that fire on the cars must make way for some better mode of heating.

Perhaps two other causes why fire was averted should, in justice, be mentioned; the cool presence of mind of Engineer WALTER E. WHITE, and the prudence of the railroad company in establishing *and enforcing* the rule that all car-stove doors should be locked. Failing either one of these, fire might have come, nevertheless; but after all, they were minor sources of safety, and merely locking the door of such a cheap cast-iron stove as appears in the center of the view, which we shall present next week, does not seem an amount of precaution to be very deeply grateful for, although it appears to have been remarkably effective.

IN the words of Sergeant BUZFUZ, "it is difficult to smile with an aching heart," but it is very difficult not to smile at the suggestion of the Boston *Globe* as to "the real cause of the accident," which is "that a weakened *span* about the center of the bridge *succumbed to the immense strain of the 300 or more souls in the rushing train*, and precipitated the living freight into the abyss below."

As an illustration of how doctors will differ, we have before us two letters, both from en-

gineers of experience, one (reprinted in another column) urging as an objection to heavy rail sections, that there are more likely to be hidden flaws in them, as in the Woodstock disaster; the other, which comes from across the water, saying, "I think the lesson of that disaster is the adoption of *heavier rails*, and not only harder rail steel, by which rails would be made more brittle and cause accidents in masses." In reality, probably the weight of rail had little or no effect on the Woodstock disaster, nor would there have been appreciably less likelihood of the fault being discovered had the rail been heavier.

In this issue we commence a monthly record of temperature, rainfall, etc., especially furnished to this journal through the courtesy of Gen. Greely, Chief of the Weather Bureau of the U. S. Army. We have attempted to so locate the points of observation that a very good general summary of the country will be presented for comparison.

We believe this record will be found both interesting and useful to engineers and others connected with our public works. The intimate relation between the prevailing temperature and the amount of fuel consumed on locotives, for example, has not been noted as carefully as it should be, and such a record will facilitate the study of this subject, and suggest its application to other than locomotive engines. The comparative rainfall over the various sections of the country, is also a good thing to have in an accessible shape, and this portion of the report will record all extraordinary floods, and phenomena of like nature. We shall likewise note in the interest of the builders of bridges and other exposed structures, any unusually heavy wind pressures that may be reported by the government officials.

We must, in this connection, express our thanks to the Chief of the Weather Bureau for the exceedingly courteous manner in which our original request for this information was received, and for the very satisfactory form in which the necessary data has been supplied to us.

LORIN BLODGETT, of Philadelphia, in a letter to *Bradstreet's*, calls attention to the difficulty of obtaining government publications by those who are really interested in their subject matter and to whom they would be valuable, and to the wholesale destruction of these documents by the paper mills.

This is a question in which we have some personal interest, and by experience know the difficulties that lie in the path of those who simply seek information as to the nature of such publications upon any subject of public interest. It is to the shame of our Washington Government that it must be admitted, that under existing methods, the bulk of the money now expended upon its publications is simply wasted. As MR. BLODGETT says, if valuable enough to be printed, means should be taken to properly distribute them; or to at least make them sufficiently accessible to the public that it may know what is printed. MR. BLODGETT further says that he is prepared to prove that one-half of certain publications go directly from Congress to the paper-mills.

The whole system should be changed; and instead of leaving this matter to the mercy of Congressmen, who rather than take the trouble of dealing them out, find it more convenient to dispose of them in bulk as "junk," there should be fixed depositaries throughout the country where at least the title could be ascertained, and the book or pamphlet ordered by any one for a price that would cover cost if necessary. There is annually much matter put into pr t that is valuable to the engineer, for example, and we know he would willingly pay for it, if he only knew of its existence. An index of such publications has been printed up to a certain date; but as no complete sets exist, outside of the Congressional Library, and copies can not now be obtained, this index is tantalizing rather than useful.

The Second Ashtabula Disaster.

The precise cause of the failure of the well-named "Tin Bridge" is already entirely clear, both from the character of the broken hangers, which we have now in this office and herewith illustrate, and from the sequence of events which followed, which are inconsistent with any other theory than that they were the first part to fail. All that remains for further investigation is to more justly apportion the blame, for no testimony of man can add to, or detract from, the evidence of the wreck itself a single essential fact as to just why and just how it occurred. By the aid of the camera we are enabled to lay every essential part of this evidence before our readers.

That the force of this evidence may be fully appreciated we must recur for a moment to the Ashtabula disaster.

The failure at Ashtabula occurred in the top chord *of the bridge truss itself*, immediately under the driving wheels of the locomotive when it was two panel lengths, or 22 ft., from the abutment. The train was running at moderate speed, probably about the same as at Forest Hill. The engineer pulled his throttle wide open, and the engine bounded forward, but not so quickly but that the bridge fell from under the tender wheels. The tender, however, was pulled up safely on the abutment by the momentum of the engine, snapping the coupling of the second following car, which fell bottom upward into the abyss.

In other words, when the truss itself of a bridge fails the collapse is complete within a fraction of a second. The Forest Hill bridge held together after a fashion long enough to let the tender and three cars, or about 160 ft. of train in all more than at Ashtabula, reach the solid ground, before it fell altogether. Allowing that the train was moving at 34 miles per hour, or 50 ft. per second, this would take 3¼ seconds. The first failure, therefore, was not in the truss proper,

The true sequence of events at Forest Hill may be summarized thus: The two hangers which we illustrate, broke as the driving wheel stood over them, 26 ft. from the abutment. It takes an appreciable fraction of a second, however, for the break to become complete even after it has begun, and there was also a certain stiffness in the rail to help for the moment. Therefore, the engine got over all right, with no other notice to the engineer than a certain unusual sinking sensation, which he could not recognize from memory, but which was the incomprehensible motive for suddenly looking back.

This dropped one side of the floor down, but left the truss and the rail intact. The tender and one truck of the first passenger coach were also able to get over (the latter in a somewhat damaged condition) before the rupture of the track had become complete, but in doing so, made a bad matter worse by completing the breakage of the floor, leaving some part of the floor system (it is useless to surmise what) projecting upward to break the transom of the rear truck of the first car, and give the powerful upward blow which so many testify to.

The bridge truss proper was still intact, but the floor-system from the last panel-point of the truss proper to the abutment, was an almost complete wreck. As the second and third cars came along, they did their best to jump this chasm, and did so, but in so doing, the trucks were knocked from under them, one by one, and they landed on the bank in the condition shown in our views. How they did so is easily seen, for fortunately the laws of gravitation remain constant in the worst catastrophes. At the probable speed of the train, a truck would pass over this gap in half a second, and were it as heavy as Bunker Hill monument at the top of the bottomless pit, it would fall but 4 ft. (4.02 ft.) in that time; a fall just sufficient to strip every car body of its trucks, but not sufficient to enable the car-bodies themselves to impinge against the abutment.

In this way the second car (18) and front end of the third car (28) got over all right, occupying about two seconds of time, but then, from some falling truck or fragment the truss proper got its *coup de grace*. The third car body was dragged complete to the abutment, but in getting there received the harder blow which so many testify to. The fourth car (87) came like a catapult against the masonry while the bridge was falling, and was utterly demolished except that it was held up somewhat by the falling bridge at the front end and by the forward car, enabling its roof to shoot forward on to the solid ground. Taking everything into account this indicates that the truss was ruptured about a car-length, or a second of time, before it struck. The three following cars (80, 81, 82,) slid down the still partially coherent bridge floor and were not utterly wrecked, but at last caused the bridge to completely fall, so that when the smoker and baggage car at the rear of the train reached the late bridge there was nothing whatever left to support it. Owing to to the great skew of the bridge, one side of this car began to fall before the other, causing it to turn bottom upward, alone of all the cars, even in the short fall of some 35 ft.

The telescoping of the second car is an additional evidence that the details of this summary are correct. To telescope a well built modern car, requires an almost immovable obstacle. That telescoping was caused by the engineer reversing his engine (had he done so) is a theory too absurd for discussion, although not, it appears, for suggestion. Such a blow as broke the rear truck of the first car is likewise far too light to cause it, and moreover, the first car kept clear of the second one. The second car, however, was stripped of its front truck, and being the first one to fall *front end down*. was driven like a ratchet pawl against the ties, and something then had to give way. The third car might have been telescoped in the same way by the car behind it, had not the abutment wall sustained the shock.

If anyone gifted with ordinary powers of putting this and that together will take the facts shown in our illustrations and endeavor to fit them to any other theory whatever, he will see how clear is the case, yet by a singular coincidence there is a tendency for the investigation to turn toward the same broken axle hypothesis as the Vermont commission. But remembering the fable of the wolf and lamb, and muddy stream, as there was no broken axle among those which preceded the truck, what broke the truck? A broken wheel-tread, or some such fault, could at most explain only why the bridge fell to-day and not to-morrow, and none such appears. It is surprising, therefore, that the investigation should run even so long as it has, on so cold a scent.

As for the bridge itself, we would not forget, nor lead others to forget, that the Boston & Providence Railroad has been and is, in the main, a truly enlightened, liberal, and well officered and managed corporation. The tower of Siloam has fallen on them, and for

good reason, but they are not [sinners above all others in Jerusalem, for many bridges have existed, and, no doubt still exist, which were almost as dangerous, and quite as really bad in essentials. But we need not point out to engineers that a more grotesque and fantastic parody on the accepted canons of good practice than this strange structure could hardly be found unless in its now illustrious predecessor, the one-iron-truss-one-wooden-truss combination. The original double track wooden bridge with only a single track over it, throwing the heavy work all on one truss, was well enough; the excessive skew was not so bad, for it dates back a long time.

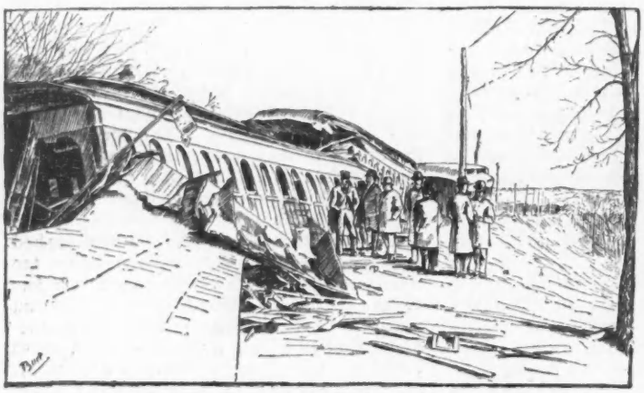


FIG. 1.—The Three Wrecked Cars which passed over the Bridge; Showing Telescoping of Second Car, and Roof of Fourth Car in the Foreground.

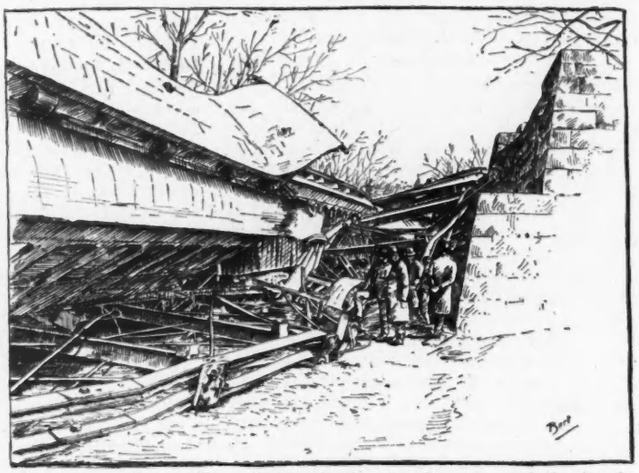


FIG. 2.—Same View as Fig. 3, looking in the other Direction, and showing the other Abutment, Wreck of Old Sixteen Panel Truss in the Foreground.

FIG. 3.—View of Wreck and South Abutment, Standing on North Abutment; showing Floor System and Wreck of Old Sixteen Panel Truss.

But when the old bridge was worn out, instead of throwing away the whole of the little structure, and building a new and symmetrical one, one leg only of the pair of trousers was thrown away, and a new leg was built to the other, as wearable a few weeks longer! At last it too wore out beyond repair, and then a new leg was built in its place, for the other, in 1876. And so per chance this pair of trousers might have lived on through a perpetual youth had not both legs at once come to grief, of a sudden, for the lack of a button!

Only by this homely parallel can one adequately picture the absurdity and the rarity of such engineering—and this from a corporation which has had great difficulty in getting rid of its surplus revenues in the past, so that they should not escheat to the State! The worst fling which her enemies have thrown at New England "nearness" has not been so cutting a reproach to her as this act of her own people, for we believe:—this is a great country, and the world is wide; there may have been many such structures, but we have never heard of one before—and we believe the annals of engineering elsewhere may be searched in vain for one.

Nothing in the catastrophe tends to show that the trusses themselves were too weak, and there has been no time for making the necessary computations. But the badness of their design in many details,—we may almost say in every detail—will be at once evident; the most conspicuous fault being that the old 16-panel truss, which was a double intersection one, was loaded after the second regeneration at every fourth panel only, *so that one entire system was wholly unloaded*, and the whole load placed on the other at every other panel point only. The hangers which caused the wreck were loaded, as nearly as may be, with 50,000 lbs. at the instant of failure, and at the passage of every train. They were so boxed in with cast-iron that a real inspection must have been difficult or impossible after erection, but the badness of the fragments now in our office, at least, must have been obtrusively evident during erection. The paint on them is good; a neat pea-green, which must have harmonized well with the landscape; but how they held together can only be explained by going to the official report of Mr. J. W. MURPHY, on the old Girard avenue wooden bridge in Philadelphia, who concluded a careful diagnosis of that ancient structure by saying: "And finally, I can see no engineering reason for this bridge standing at all, except it be—from sheer force of habit."

The Wrecked Bridge.

The Bussey, or "Tin Bridge" was on the Dedham Branch of the Boston & Providence Railroad five miles from the terminus in Boston, and spanned South street, or the old Norfolk Co. Pike, in what is now the Twenty-third Ward of the City of Boston, formerly West Roxbury. The bridge was originally of wood, and both bridge and embankments were of width for two tracks; only one track, however, was laid, and that was on the northwestern side. It was on a very sharp skew, as shown on the plans.

Mr. HENRY S. PRITCHARD, C. E., who investigated the accident in our behalf, has drawn up the following memoranda as to the structure, which, with the engravings, will make its general nature clear. For the engravings we are indebted to a number of Boston engineers, including one student of the Institute of Technology, whose modesty is even greater than his energy, so that we must thank him anonymously, as we do most heartily.

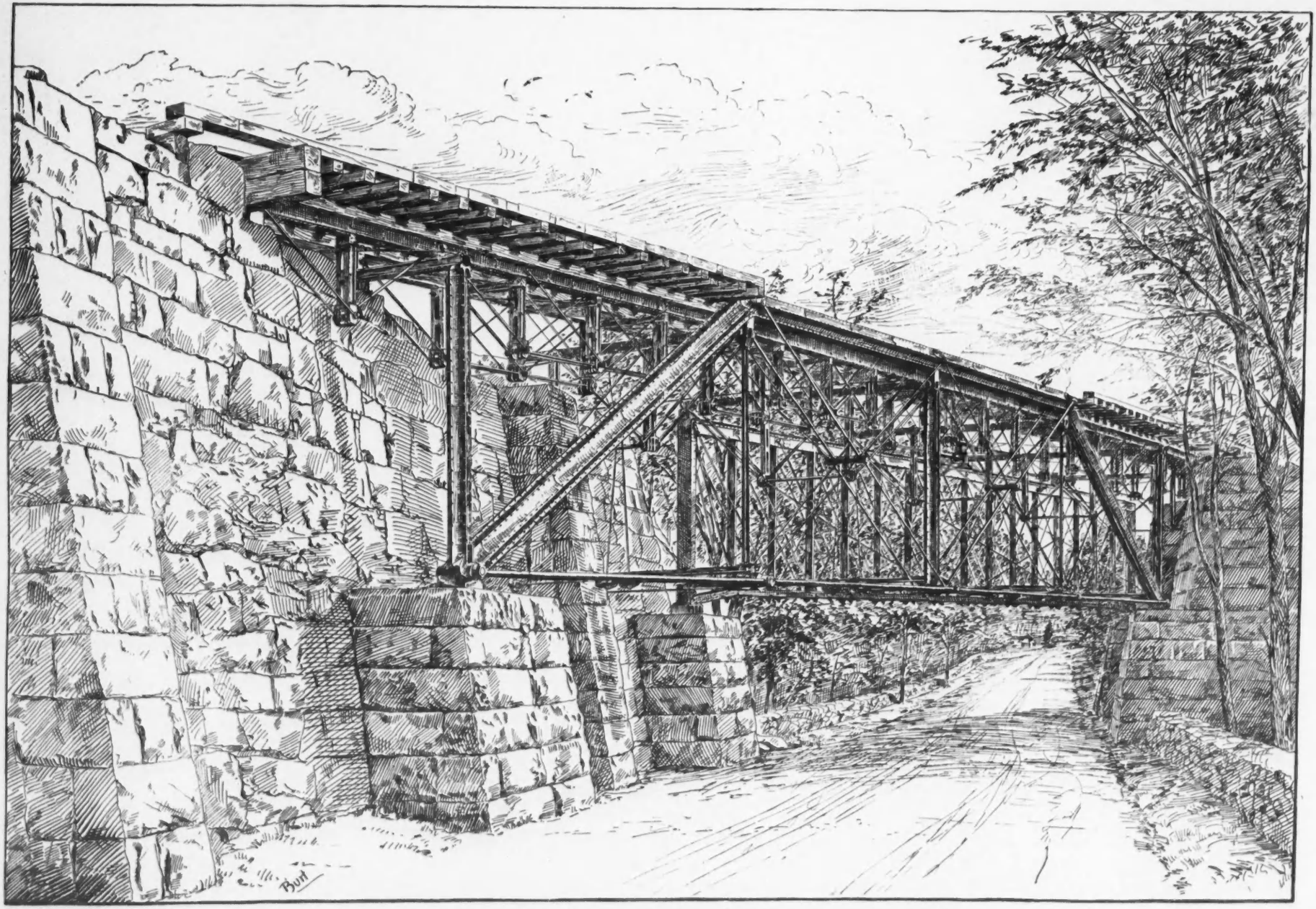
As copies of the original plans and drawings could not be obtained and as the bridge is a complete wreck, it was difficult to obtain exact information, and the plan of the bridge and elevations of the trusses were made from sketches, and measurements made from the members left in the wreck.

The bridge was originally a wooden Howe truss, built for double track, but with only a single track over it. In 1869 *one* of the trusses was replaced by a wrought-iron one (marked *B* on the plan) by C. H. Parker, the other wooden truss being retained. Finally, in July, 1876, this iron truss was shifted to the opposite side of the bridge from which it had originally been, and another wrought-iron truss, of entirely different design and dimensions was built (marked *A* on the plan) and the two trusses united together by laterals into one bridge. The first built truss, *B*, was a double intersection Pratt truss. It measures 104 ft. center to center of end pins, and had 16 panels of 6 ft. 6 in. each, and a depth of 12 ft. 6 in., center to center of pins. The end posts and top chord were built of plates and angles as shown. The intermediate posts were 8 in. I-beams. The diagonal rods had one pin end connected to the top chord, and one screw-end connected by a casting to the bottom chord, and the bottom chord consisted of four 6 in. bars, varying in thickness from ⅝ to ⅞ inches.

Truss *A* measured 104 ft. center to center of end pins, had four panels of 26 ft. each, and a depth of about 16 ft.

It had pin connections, diagonal end posts, and built closed columns, with cast-iron connections.

The bridge was about 18 or 20 ft. wide. The track



THE "TIN BRIDGE" NEAR FOREST HILL, BOSTON & PROVIDENCE RAILROAD.

AS IT WAS BEFORE ITS FALL ON MARCH 14, 1887.

curved slightly and was so much to one side that over three-fourths of the load came on truss *A*.

The floor-beams were double, deeply-trussed, and composed of I-beams and round rods. They were suspended from the top chord of truss *A*, but rested on the top chord of truss *B*, thus eliminating the effect of their different height.

The stringers were composed of I-beams and rods, and rested on the floor-beams. The writer's memory of the top lateral system is that it consisted of round rods about one inch diameter with bent eyes connecting with the floor-beam pins.

Truss *A* was apparently connected by a rod to a point in the Boston abutment near the end of truss *B*. One end of the rod remained anchored to the abutment after the accident.

The floor-beams nearest to the Boston abutment were suspended from the top chord of truss by two hangers. (The ones illustrated herewith, which appear to have caused the disaster.—ED.) One end of each of these hangers went between the two -beams which composed the top chord of the floor-beam and connected to a pin in the floor-beam. The other end went into the casting at the intersection of the diagonal end post and top chord and connected with the chord pin. One of these hangers had been almost completely fractured for some time, as is shown by the very rusty appearance of the fracture.

The fracture of the other hanger was mostly bright but had bad flaws in it, and the welding of both hangers was defective.

When in position the hangers were nearly covered from sight, making proper inspection very difficult.

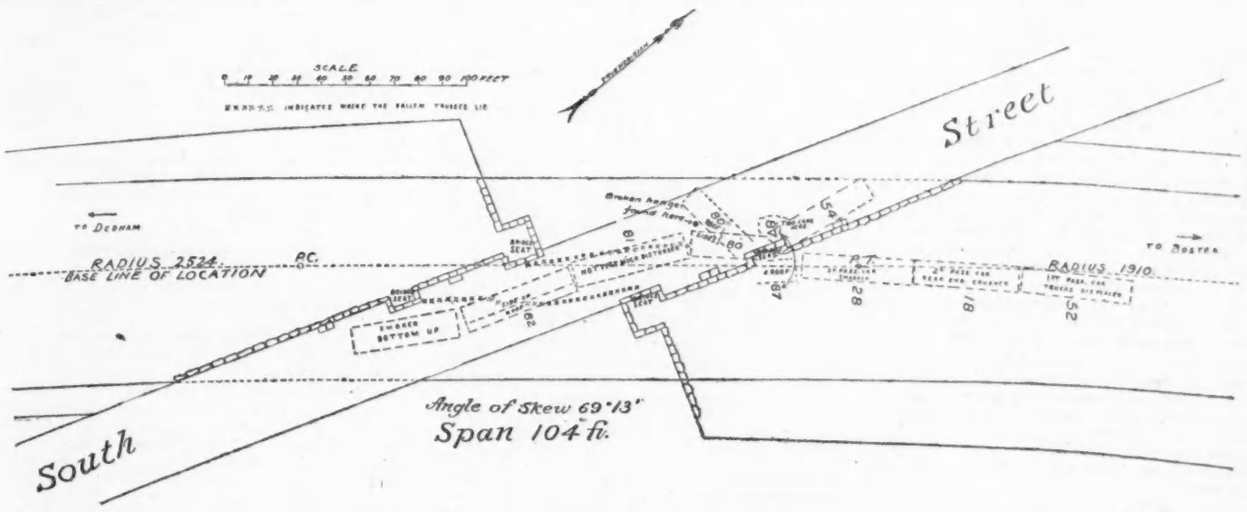
At 7:15 A. M. on March 14, 1887, the bridge was broken down by the passage of a train consisting of a locomotive, 8 passenger cars, and 1 combination car, having smoking and baggage compartments. The locomotive was one of the most powerful type in use for the suburban service, as we infer, a 17 x 24 engine, with perhaps as much as 60,000 lbs. on the drivers, or even more.

The ruins of the bridge show the mark of a very heavy blow received at the top of the planting post, about one-fifth (?) of the way from the northerly end of the northwesterly truss; that is, about at the top of the joint box where the bad hanger was.

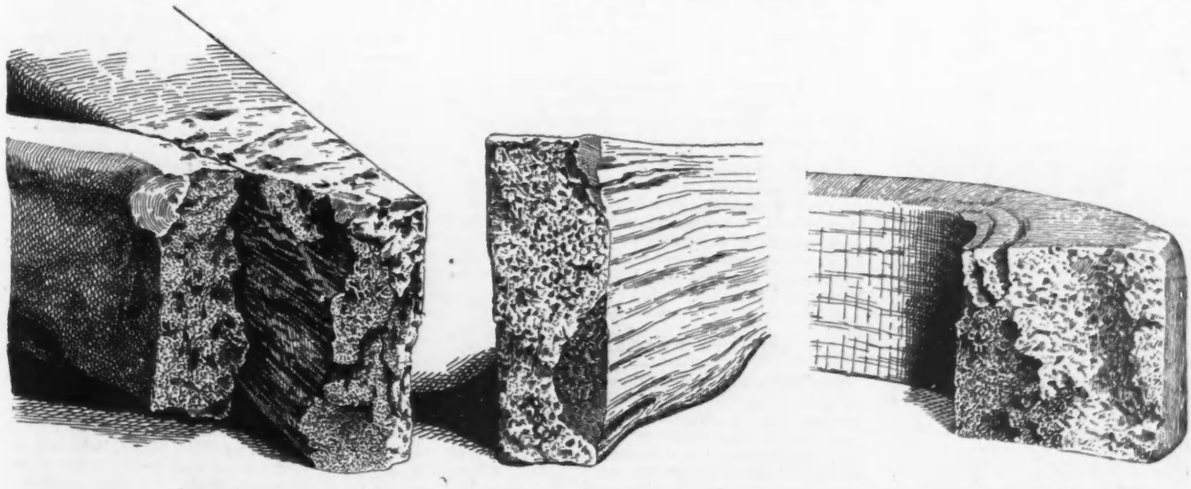
A correspondent writes us:

The most probable theory that has yet been suggested to account for the accident (and I think it was very early suggested by HENRY MANLEY, of City Engineer's office) is that the defective hangers, by which the floor-beam was supported below the truss, having given way under the weight of locomotive, some portion of the falling train struck upon the top of the post, and displaced it from the plane of the truss, upon which the truss fell to pieces, as MANLEY says, "like a card house."

Location of the Bussey Bridge Disaster.
(Within city limits of Boston.)



The Bussey Bridge Catastrophe—Ground Plan of Wreck.



A. *B.* *C.* *D.*

The Bussey Bridge Catastrophe. The Two Broken Hangers Whose Failure Caused the Wreck.

(From Photographs of the Original Broken Parts, now in the Possession of this Journal.)

These hangers were duplicates of each other and worked together on the same pin, supporting the floor-beam at the first panel point (over the inclined end-post) of the northerly, or newest and most loaded truss, counting from the further or Boston abutment. The point where found is shown on the ground plan and their position in the truss in the elevation.

A. B. The fracture at the loop-weld of the most defective hanger; dotted portions show old and much rusted surfaces, including the so-called weld. The only fresh fracture is on the extreme edge of *B*, undotted. A bad crack extends up and down almost through *B*. The weld shows exceedingly bad metal and workmanship.

C. D. The two fractured ends of the other hanger, which came from the same pin as *A. B.* The dark portion in *C* shows an old and rusted susface of very bad iron-peculiar in appearance. The remaining surface is irregular in texture, and is covered with large, fiery crystals of badly worked iron. Bevond the fracture is imperfectly shown the supposed weld; this is a burned, striated surface, showing conclusively that there never was a weld-connection between the two portions of the loop. *D* shows by dotted surface an old, rusted break, the remaining face being likewise filled with large, fiery crystals: but on the whole this fracture shows the best metal of the four breaks. Long splits, as shown, extend backward from the fracture, and the inner and outer faces of the loop show the original piling of the scrap.

The hanger *A B* can not have been strained at all for years, as even the thin edge of bright metal left was defective. In the hanger *C D*, the weld was so defective that *C* (the main stem) must have had upon it practically all of the load. The fracture in *D* (about opposite center of pin) may have been due to an impact or other secondary cause in the general wreck.

The track being upon the northwesterly side of the bridge was not far removed laterally, from the plane of the truss, and the floor-beams being suspended just under the under side of the top chord, the track was not much elevated above the chord.

In addition to the defective hangers shown, several of the press accounts mentioned other flaws in the various members. In one case, a "12-in iron truss" was found with "fully 8-in.—of the fracture black with rust and dirt"; but the account does not locate or further describe this member. One of the "cast-iron boxes"—apparently a connection in the Parker truss—is also noted as showing an extensive fracture of long standing.

Mr. FREDERICK BROOKS, C. E., of Boston, to whom we are chiefly indebted for being able to present such full illustrations and details of the catastrophe, writes us:—

"Professor VOSE tells me to-day that Mr. EDWARD HEWINS has only a strain sheet and very insufficient sketches of details, but says the working drawings were probably left with the company that built the bridge, and are not supposed to be in existence for any practical purposes. It occurs to me to mention this, because the built columns are marked Trenton, and I thought they might have been made by the New Jersey Company for which Mr. PRICHARD used to work, but I cannot be sure now that the New England Bridge & Iron Co. was not intended, with which I think Mr HEWINS was formerly connected. Prof. VOSE says that about as little is known concerning the PARKER plans. Prof. VOSE, you must understand, is now acting for the Railroad Company. He says Mr. HEWINS feels badly about the accident. I saw Mr. HEWINS about six o'clock Monday evening when he was very polite, but said he did not like to give detailed information without the knowledge of the railroad authorities, and that if I would get Superintendent A. A. FOLSOM to authorize it, he would do so, but Mr. FOLSOM did not accede. I understand he is acting under legal advice. He, Mr. F., said the Railroad Commissioners were to begin an investigation at half past two Tuesday afternoon, that they would be likely to bring out all particulars, and if wanted facts I had better attend the hearing.

"I have sent on such diagrams as I could provide any material for, (unless possibly the details of the joint where the hanger was suspended have been omitted): but it is possible that the spot where the broken hanger lay on the ground, may not have been noted. The parts were found not very far from the east corner of car 81, the one which stood in the middle of the street, comparatively unharmed.

"So far as I can learn, it was one of the students of the Institute of Technology, who first discovered the defect in the hanger. I saw several of them looking at it, and it was Prof. VOSE who first called my attention to it. I heard Prof. SWAIN credited, about Monday noon, with having explained the fall of the bridge by this defective hanger."

The cars after the wreck stood as follows, beginning with the engine:

Car 52. Near the track, about 400 ft. from bridge, minus both trucks. This car by the engineer's testimony was the first one to topple over, and by other accounts "its rear truck first went wrong." Occupants much shaken but not hurt.

Car 18. Swept from its trucks but still near the track. Rear six feet of body, and platform much crushed. The car behind evidently impinged violently upon it. Occupants were thrown violently forward, and many seats torn loose.

Car 28. The last on the embankment. Wrenched, torn and badly demoralized, as were also the passengers, but retains its general shape. Lying partly on its side, about 60 or 80 ft. beyond the abutment.

Car 87. The first utterly wrecked car. Almost every one in it killed. Bridge entirely gave way under it. The body dashed against the solid wall, and the roof shot forward on to the roadbed. So complete was the wreck, that this car was left entirely out of the first accounts of the wreck. The only clear evidence of its existence for half a day was its roof.

Car 54. Impinged directly against the abutment and glanced slightly to the left, covering the remnants of 87. An almost complete wreck, but the stove did not break from its fastenings, but cracked, letting out fire which was put out by the chemical engine. A much bent steel rail covers it.

Car 80. Partly on 54. Roof fell off. Several killed and injured.

Car 81 *and* 82. The first badly wrecked, the second less so. Many were injured but few killed in them.

Baggage and Smoking Car. Fell bottom upward, killing three and injuring all the rest. The left truss, if not both, had evidently completely fallen when it reached the bridge, and not before, and the skew let the left side drop first. The first three removed from this car were taken directly from under the stove which still hung to what had been the floor, bottom upwards, and still full of fire.

The positions of these cars are shown more clearly in the ground plan on page 191. They are important as indicating the course of events.

PERSONAL.

MAJOR DANIEL C. OAKES, Civil Engineer, died at his residence, Denver, Col., March 9.

L. W. RUNDLETT, has been re-elected City Engineer of St. Paul, Minn.

EUGENE H. YORK, formerly of the Portland Gas Co., has been appointed Superintendent of the Augusta Gas Co., Augusta, Me.

GEO. H. WATBONS has resigned the position of President of the New York, New Haven & Hartford R. R., and has been succeeded by CHAS. P. CLARK.

Lt. J. S. POWELL, of the U. S. Signal Service Bureau, died in Washington on March 14, from softening of the brain.

JAMES C. BAYLES, editor of the *Iron Age*, was appointed by Mayor HEWITT, on March 14, President of the Board of Health of New York City.

L. P. WAKEFIELD has been appointed Chief Engineer of the Sioux City & Northeastern R. R., and on March 5 started location from Belmont, Iowa, to Sioux City.

C. A. THOMPSON has been appointed General Inspector of Motive Power and Equipment on the Philadelphia & Reading R. R.

EX-SECRETARY WINDOM, now President of the Huantepec Ship Railway Co., will according to Washington despatches succeed the late Capt. EADS, as the leading man in that enterprise.

COL. A. B. JEWETT, Vice President of the St. Johnsbury & Lake Champlain R. R., died at Jacksonville, Fla., March 7. He was Superintendent of the road until last year.

JAMES WATERS, Engineer of the Water Department, Minneapolis, Minn., has been notified that his services are to be dispensed with, his duties being transferred to the City Engineer. J. W. HENION will be retained as Superintendent.

CORRECTION.—In our issue of March 12, the personal concerning Mr. EMIL SWENSSON was incorrect. It should read that Mr. EMIL SWENSSON, late in the Phœnixville office of the Phœnix Bridge Co., and formerly Assistant Engineer on the South Pennsylvana R. R., is now connected with the Keystone Bridge Co. with headquarters in the Pittsburg office.

GEN. LOUIS WAGNER, was appointed on March 14 Director of Public Safety, by Mayor Fitler, of Philadelphia, Pa., under the new charter. This office is about equivalent to that of the Commissioner of Public Works in New York.

Maj. H. G. PROUT has been appointed editor of the *Railroad Gazette* in place of Mr. W. HOWARD WHITE, resigned. Maj. PROUT is a graduate of the University of Michigan, and was for several years in the service of the Khedive of Egypt, on the engineering staff, under the late Gen. CHAS. P. STONE. Since his return to this country he has been the junior partner of the publishing firm of ATKIN & PROUT, of this city, and editor of the *Journal of the Association of Engineering Societies*, with which most of our readers are familiar.

EDWARD BARRINGTON, of Washington, D. C. has been appointed Chief Engineer of the Wichita, Cedarvale & South Eastern Ry., with headquarters at Wichita, Kan. Mr. BARRINGTON was recently engaged upon the location of the Chicago, Santa Fé & California Ry., from Streator, Ill., west towards Fort Madison, Ia., and previously to that was Division Engineer of the Minnesota & Northwestern Ry.

SOCIETY PROCEEDINGS.

Civil Engineers' Club of Cleveland.—The seventh annual meeting of this club was held March 8 at Cleveland, Mr. CHAS. LATIMER presiding and some 30 members in attendance. Secretary C. M. BARBER reported a total membership of 127, with an average attendance of 18 per cent. at meetings. Treasurer S. J. BAKER reported $699.44 received from dues in the year past. Mr. W. H. SEARLES reported for the committee on civil engineering, and other reports were submitted by Messrs. W. R. WARNER and JOHN EISENMANN. Mr. AUGUSTUS MORDECAI read the paper of the meeting, entitled "Railroad Engineers," in which he referred to their value as factors in the world's advance; showed that they were now invading China, Africa, Algiers and the once remote regions of the globe, and in Europe are improving on the methods of a preceding generation. Mr. MORDECAI then referred to the work at home, the miles of road built and the money expended and labor employed. The committee on Standard Time reported that a committee of the city council of Cleveland, reported unanimously in favor of its general adoption; but that the measure was lost by a tie-vote in councils; but the club still has hopes of its ultimate adoption. The annual banquet was given at the Kennard House on March 15. The officers elected for 1887 were:—President, JOHN WHITELAW; Vice-President, W. R. WARNER; Cor. Secretary, C. O. ABEY; Rec. Secretary, C. M. BARBER; Treasurer, S. J. BAKER; Member of the Board of Managers of the Association of Engineering Societies, M. E. RAWSON.

Liverpool Engineering Society.—The usual fortnightly meeting of this Society was held at the Royal Institution Colquett street, Liverpool, on Feb. 23, Mr. JOHN J. WEBSTER, M. Inst. C. E., President in the chair. A paper was read by Professor HELE SHAW. The object of the paper was to try and place before the Society a concise statement of the methods adopted, and the results obtained by those who had devoted attention to the testing of steam engines, and this amounted in point of fact to a practical statement of our present view of the theory of the steam engine itself. The author proceeded to discuss the determination of the efficiency of engines, under the three heads. (1). The transfer of heat. (2). The tranformation of energy. (3). The transmission of power, and illustrated the methods adopted by diagrams and actual results obtained by himself, and other observers.

The meeting on March 9th, was devoted to the discussion of the paper.

The Engineers' Club of Kansas City held its first formal meeting Monday evening, March 7, in their room, No. 19, Deardorff Building.

A paper was read by Mr. EDGAR B. KAY, member of the Club, on "Sewer Gas," treating at length its chemical and physical properties, its malign influence on the health, and the best means to be employed in its detection and prevention.

After an animated discussion of the paper by those present, it was decided to have it printed.

The interest taken in this first meeting argues well or the future of the Club.

PUBLICATIONS RECEIVED.

Rules and Tables for Permanent Way Inspectors, being a Collection of Useful Information for Practical Men for 5 ft. 6 in. and Metre Gauge Railways. By T. W. JONES. Permanent Way Inspector, East Indian Railway, Calcutta. W. NEWMAN & Co., pp. 96, 8 vo.; 21 plates and many tables.

As the two gauges specified above do not exist in this country, there is not likely to be any large demand for this book, and, like so many others, Mr. JONES seems to have made rather a hobby of what is really a small subject, and have multiplied his switch and crossing tables unnecessarily, while much of his other matter is selected from American sources; yet it is but just to add that much of it is not, and that engineers of maintenance of way will find some useful hints in the volume. We hardly know what Mr. JONES means, however, when he says: "Having often felt the want of a useful Book of Tables, *and not being able to procure one in England or America*, I, some years ago, commenced a set for my own use, and these I have now decided to publish," etc. We think we could have referred him to one or two at least.

General Specifications for Railway Bridges and Viaducts of Iron and Steel, and—

General Specifications for Highway Bridges and Viaducts of Iron and Steel. G. BOUSCAREN, Consulting Engineer, Cincinnati, O. Folio, 8 pp.

Census of Massachusetts, 1885, Vol. 1. Population and Social Statistics. Prepared under the direction of CARROLL D. WRIGHT, Chief of the Bureau of Statistics of Labor. State Doc. pp. 685.

This is on the whole the most complete State census taken, and the volume contains a great deal of interesting matter, some of which we have noted.

THE iron bridge over the White River, which will be built by the Vermont Construction Co., of St. Albans, to replace the one destroyed in the Hartford disaster, will be a deck bridge, "supplied with a safety guard devised by ex-Gov. SMITH," which bears a striking resemblance, we apprehend, to that illustrated by ENGINEERING NEWS. It will be of five spans, 650 ft. long, of the rivetted lattice system, and 475 tons of iron will be used in its construction. The bridge is to be finished within seven weeks of the time the iron reaches St. Albans. The same company are working on a railroad bridge at Brattleboro, one span of which is 217 ft. long.

MR. WM. JOS. DIBDIN, in a late paper on "Sewage Sludge and its Disposal," read before the Inst. C. E., said that the average of suspended matter in London sewage was about 27 grs. per gallon. Of this 27 grs. about 15 grs. was of an organic nature. The liquid portion of the sewage contained in solution about 60 grs. of solid matter, 20 grs. of which were organic

The Weather of the United States for the Month of February, 1887.

[As respects the elements of most interest to engineers.]
According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	TEMPERATURE. Degrees Fah.			WIND-VELOCITY. Miles per hour.			PRECIPITATION. Rain and melted snow. Inches.		
	Average	Max.	Min.	Average	Max.	Direction.	Total.	Heaviest in 24 hours.	No. rainy days.
NORTHERN CITIES.									
Northfield, Vt.	(Forms not received.)								
Portland, Me.	22.2	41.9	2.5	8.1	28	NW, W	5.73	1.73	13
New York City.	33.7	63.0	16.6	10.7	46	NW	5.26	1.64	14
Pittsburg, Pa.	38.5	66.6	15.1	9.2	40	W	6.52	2.01	15
Chicago, Ill.	27.1	58.0	7.0	10.8	42	W	5.10	1.23	17
Omaha, Neb.	18.2	59.0	15.5	8.0	36	NW	1.00	0.32	10
St. Paul, Minn.	9.7	42.8	26.7	6.4	26	NW	0.89	0.61	10
Duluth, Minn.	9.7	43.6	23.1	7.2	38	NE	0.81	0.23	12
Bismark, Dak.	3.6	45.2	42.8	6.6	40	NW	0.52	0.18	11
SOUTHERN CITIES.									
Washington City.	38.9	73.0	18.6	6.4	33	NW	3.42	0.69	13
Louisville, Ky.	43.0	77.9	19.2	9.4	36	S	7.60	2.48	18
St. Louis, Mo.	40.6	74.1	3.9	11.3	45	NW	3.68	0.56	14
Savannah, Ga.	58.7	79.7	34.9	7.8	32	NE	3.63	1.08	14
Leavenworth, Kan.	28.9	68.4	6.0	8.2	30	NW	1.94	0.57	15
Jacksonville, Fla.	64.4	83.6	38.2	5.3	32	SW	0.34	0.20	3
Chattanooga, Tenn.	51.2	73.8	26.7	8.0	44	NW	7.16	1.58	22
New Orleans, La.	65.2	81.5	44.0	8.7	32	N	5.58	2.49	13
Memphis, Tenn.	49.0	74.0	26.0	7.5	32	SW	8.37	2.35	15
Palestine, Tex.	54.7	81.1	22.8	11.3	37	NW	3.87	1.42	10
WESTERN CITIES.									
Helena, Mont.	5.0	61.0	40.5	4.9	30	W	0.61	0.28	13
Port Angeles, W. T.	28.9	53.4	2.6	5.5	25	NE	4.68	1.10	15
San Francisco, Cal.	47.0	67.0	33.1	8.5	28	W	9.24	3.60	15
Salt Lake City, U.	34.0	53.4	13.0	8.0	33	S	1.41	0.47	13
Denver, Col.	32.0	70.9	2.6	8.7	64	W	0.30	0.22	5
Yuma, Cal.	56.1	83.0	34.9	8.6	41	SE	—	—	0
Santa Fé, N. W.	(Forms sent back to station.)								

TECHNICAL NOTES.

A. L. STEVENSON has been describing to the North of England Inst. of Mining Engineers, a method of drilling holes in iron ore by the use of a turbine. Water at a pressure of 215 lbs. per sq. in. was conveyed into the working by pipes connected with a drill and a turbine mounted on a strong carriage. The work done by this contrivance in Oct. 1886, averaged over 152 tons of ore extracted in 8 hours. The water consumed is 31 galls. in 28 seconds, or 66.4 galls. per minute when the drill is running. In 79 minutes, 76 ft. 3 in. of holes were drilled, 17 at different points. About 7,000 galls. of water per day were used.

Dr. PERCY FRANKLAND shows (Proc. Roy. Soc. June 10, 1886) that the micro-organisms in a few drops of urine introduced into distilled water multiplied extraordinarily; after hours 0, 6, 24, 48 he found per cubic centimetre 1,073, 6,028, 7,262, and 48,100 colonies. Leone observed that five multiplied to half a million in Munich water within five days. Dr. Frankland found that in cold or even ordinary temperatures the numbers decreased slightly; but 95° F. seemed to be very favorable to an enormous increase.

THE Boston & Albany estimates the cost of heating cars by stoves at $50 a year; the Old Colony at $35 or $40; the Providence, Warren and Bristol at four or five tons of coal a year apiece. Supt. WATERMAN STONE, of the latter road, which is heating cars by the Gold system, says that he does not see that the steam costs anything, and sees no reduction of pressure on the engine.

BY the explosion of 13,000 lbs. of gunpowder at Craral Quarry, Loch Fyne, Scotland, on Sept. 25, 1886, many of the bystanders were affected by the gases and seven of them died. Col. A. FORD in a late report upon this accident says that the mischief was probably due to the carbonic acid, of which 468 lbs. were generated by the explosion; an amount which at ordinary pressure and temperature would occupy 6333 cu. ft. of space. This would vitiate one hundred times as many cu. ft. of air; but in the presence of carbonic anhydride—of which 3575 lbs. were generated—it would render 1,266,600 cu. ft. of air fatal to life. The symptoms agreed with those attributed to poisoning by carbonic anhydride, and the blood of one of the deceased was so liquid as to flow through the coffin.

IRON and its compounds are rendered unoxydizable by the electric current as follows:—Objects to be "bronzed" are placed to form the anode in a bath of distilled water maintained at a temperature of 158° to 176° F; the cathode being formed of copper, iron or carbon. The electric current must be sufficiently intense to decompose the water, and be regulated as in ordinary electro deposition to render the layer adherent and uniform. After one or two hours the layer of magnetic oxide will be found firm and capable of receiving a high polish. This is for the treatment of steel; wrought, malleable or cast iron requires a modification of the process, as follows:—The objects, after forming the negative pole of the bath, must subsequently be submitted to the action of the current at the positive pole, when the oxide will be reduced and the pores of the metal charged with occluded hydrogen. By again making them form the anode, the result wished for is obtained.

JOHN C. GOODRIDGE, JR., well-known for his long experience in the use of béton, has patented an improved method of depositing concrete under water so as to present a homogeneous mass and prevent washing on its passage through the water. This he accomplishes by using his béton or concrete in paper bags, holding from one to five cubic feet and sliding them to the bottom on an inclined way. The advantage over woven bags is that with paper the bag bursts on being wet and the concrete is brought in immediate contact with previous layers. Mr. GOODRIDGE shows its application to many conditions of construction and repair and also various methods of deposit by sleds, endless belts, buckets, etc.

REPORT has it that the Great Eastern has been bought by the London & Australian Steamship Co. JOHN ELDER is to remove the old side-wheels and substitute screws with new engines to drive them, at a cost of about $600,000. They expect to obtain a speed of 20 knots by the change, and the ship will be used in the transport of freight between England and Australia.

IN connection with the use of coal gas for trade purposes, Mr. HENRY WOODALL, gas-engineer of the Leeds Corporation (England) said that coal-gas costs in the holder, and including general charges and interest, 22 cts. per 1,000 cu. ft. Mr. LIVESEY, another well known gas engineer, said that gas could be put into the mains for 14 cts., and a carbonizing company at Normanton offered coal gas at 12 cts. per 1000 cu. ft.

A PROSPECTUS of the Birmingham & Liverpool Railway, of 1824, promises "to transport heavy goods at the rate of at least 8 miles per hour," and states that "passengers may also travel with perfect security at the rate of at least 12 miles per hour, but to this the company will not pledge itself." The same company in 1830 notes "that engines with passengers have frequently been known to exceed the velocity of 30 miles per hour, but a rate of from 10 to 20 miles per hour has been established as safe in operation and certain of attainment. This extraordinary rapidity is accompanied with a motion so gentle and easy as to excite no alarm even in the most timid."

CONSTRUCTION NEWS.

Water.

Buffalo, N. Y.—It is proposed to dig a canal and make other improvements for draining the flats where the floods have caused so much trouble.

Muskegon, Mich.—The Water Board has accepted the proposition of A. L. HOLMES, of Grand Haven, to supply the city with water from the lake at a cost of about $150,000.

Bradford, Pa.—A new reservoir is to be established on Gilbert brook; the specifications for constructing the dam and masonry have been prepared by J. A SEYMOUR, City Engineer. Proposals will be received by the City Clerk until March 21.

Housatonic, Mass.—A charter has been granted for water-works for the village; the source of supply has not yet been fully decided upon and will not be until a survey has been made. The surveys and plans will be made, as soon as the weather will permit, by HULL & PALMER, Civil Engineers, Bridgeport, Conn.

Mount Joy, Pa.—The report on the water-works for 1886 has been issued, being the twelfth annual report. The operation during the year was satisfactory, but it is recommended that the reservoir be cleaned this season. A new water race has been constructed which is a great improvement on the old one. WILLIAM KUHN is Superintendent.

Lynn, Mass.—The new pump recently purchased by the city has been placed at the upper end of Birch pond; it has a daily capacity of 30,000,000 gals., and will pump water into the pond from the canal which brings the supply from Hawkes and Penny brooks. The Water Board intends to store water in the pond when the brooks are full, for use in summer when the brooks are low.

Sedalia, Mo.—The City Council has passed an ordinance transferring the city water-works and the franchise for 21 years to Quigley & Co., of St. Louis, Mo. The firm will pay $100,000 cash and guarantee to erect two steel stand-pipes 125 ft. high, with a capacity of 1,500,000 gals. each, a settling reservoir of 50,000,000 gals. capacity and a new set of pumping machinery with a daily capacity of 50,000,000 gals.

Newtown, Conn.—A private company contemplates putting in water-works. The supply will be taken from Taunton lake, about one mile west of the village, and pumped into a reservoir on the hill between the village and the lake, and thence to the village. The reservoir will have a capacity of 600,000 gallons, large enough to avoid constant pumping. The surveys will be made by HULL & PALMER, Civil Engineers, Bridgeport, Conn.

Plainfield, N. J.—C. P. BASSETT, C.E., of Newark, N.J., has submitted his report on a system of water-works and sewerage to the Town Council, and we understand that it has given great satisfaction. The estimate of cost is stated to be much less than any bids submitted by contractors, an evidence of the advantage of employing an engineer for such works. The report will be published in pamphlet form, and will then be further noted in our columns.

Cedar Rapids, Ia.—Proposals for a pumping engine of 2,000,000 gallons daily capacity are being received by the Cedar Rapids Water Co. from builders of water-works machinery, and the city has ordered the laying of about three miles of cast-iron pipe this year. It has been voted to bond the city for $100,000 to put in a system of sewerage in accordance with plans furnished by CHESTER B. DAVIS, C. E., of Chicago; work will be commenced as soon as the bonds are placed on the market. C. J. FOX, is Superintendent of the Water-Works.

Worcester, Mass.—The last Legislature passed an act requiring the city to find a way, within four years, to purify its sewage before emptying it into the Blackstone river. City Engineer ALLEN has a plan for treating the sewage by chemical precipitation, and several other plans and suggestions have been made. On March 9th a hearing was given at the State House, Boston, but nothing definite resulted. Mayor WINSLOW, City Engineer ALLEN, Superintendent of Sewers CHAMBERLAIN, and others, attended in behalf of the city, and Col. GEO. A. FLAGG, and others, in behalf of the town of Millbury.

Sewerage.—Bar Harbor, Me. It has been decided to put in a system of sewerage, the work to be done under the supervision of E. W. BOWDITCH, C. E., of Boston; $50,000 will be raised for this purpose.——Laramie, Wyo. A system of sewerage is proposed, to cost about $40,000.——Winona, Minn. Bonds for $75,000 for sewers will be issued.—Milford, Mass. Work is to be commenced this season on the sewerage system; E. W. BOWDITCH, C.E., of Boston, is the engineer.——Greeley, Co. A vote will be taken April 5 for the issue of $15,000 bonds for sewers.——Clifton, O. A sewerage system is contemplated, which will cost about $40,000. Plans have been prepared by Engineer HOBBY.

Culbertson, Neb.—Col. W.W. PATTERSON, of Kearney, Neb., has engineers at work making surveys and estimates for the utilization of the water power.

Middletown, Conn.—The Board of Water Commissioners has submitted its report for 1886. The water has been good with the exception of a disagreeable fishy taste in April, which was got rid of by thorough flushing. Cast-iron mains have been laid 3, 4, 6, 8, and 10-in.; hydrants have been set, bringing the number up to 100; 14 gates were put in. Sundry repairs have been made. J. C. BROATCH is Secretary and Treasurer.

Roanoke, Va.—A large reservoir is to be built at once to take the place of the present system of direct pumping, it will be situated on the mountain side and the water will be pumped into it from the spring: it will give considerable pressure. Work will be commenced as soon as the plans can be completed. Address C. O'LEARY, Land Agent, Roanoke Land & Improvement Co., Roanoke, Va.

Salem, Mass.—The Water Board has presented its report for 1886. Necessary repairs to the works have been made and the pumping machinery is reported to be in fair condition, considering its length of service, but certain parts will need to be renewed soon. The city now supplies Beverly, but the new works for that town are nearing completion, after which the pressure in the Salem pipes will be increased. Of distribution pipe, 4,850 ft. of cast-iron pipe have been laid, 12 new hydrants, and 13 gates set, and two more meters put in, making a total of 140; 128 new services have been put in. BENJAMIN S. GRUSH is Superintendent.

The Watkins Pipe-Jointer.—Capt. THOS. W. SYMONDS, U. S. Engineers, and Engineer-in Charge of the Washington Aqueduct, says he has made 560 joints on 48-in. pipe with *one* of these jointers without a single mishap; and the work was done "better, quicker and more cheaply" than would have been possible with the old clayed rope method. This is a valued testimonial to the merits of a really most excellent device, that is rapidly finding a place everywhere in the pipe layers plant, once used is never laid aside. It replaces the old clayed rope with pliable steel bands and gum gasket, more easy of application, dispenses with the service of two men in laying large mains and thereby saves on wages about $2.50 per day. One 36 in. jointer has been known to lay 1,000 joints of pipe and was then as good practically as before.

Rockland, Mass.—The Water Commissioners and Construction Committee have submitted their first annual report. The first action in relation to a water supply was taken in Sept., 1883; and two reports were made by SIMPSON C. HEALD, C. E., of Worcester; (see Town Report, 1883). In April, 1885, the Governor approved an act to supply with water the towns of Rockland, Abington and South Abington, the full text of which act is given. The bid of Brewster, Cobb & Estabrook, of Boston, for the purchase of the water bonds, was accepted. An additional act was passed April, 1886, to exempt South Abington from liability for any part of the expense of the stand-pipe. SIMPSON C. HEALD was the engineer in charge, and during his absence in Europe the work was in charge of J. J. VAN VALKENBURG, of Worcester; PHINEAS BALL, of Worcester, was consulting engineer.

The contract for pipe was let to the Warren Foundry & Machine Co., Phillipsburg, N. J., at $27.40 per ton for pipe and $52 per ton for special castings; the contract for laying pipe, etc., was awarded to Thomas F. Maney & Co., of Boston, at 16, 20, 25 and 27 cts. per ft. for 6, 8, 10 and 12-in. pipe, and $2.35 per cu. yd. of rock excavation. The contract for the steel stand-pipe was awarded to the Cunningham Iron Works Co., of Boston, for $9,700 and $450 for balcony; this stand-pipe is 25 ft. diameter and 100 ft. high, and is built of plates ⅝, ½, ⅜ and $\frac{5}{16}$-in. thick. The contract for pumping plant was awarded to Henry R. Worthington, of New York, for $16,800, this included one high duty and one high pressure engine, a condenser, feed water heater and two return tubular boilers. The contract for gates and hydrants was let to the Coffin Valve Co., of Boston, at $30.25 each for hydrants, and from $13.50 to $39 for 6 to 12-in. gates. The pumping station buildings were erected by Q. A. Faunce and Elijah Faunce, and the service pipes were laid by Bevan & Fantom, of Marlboro. The filter gallery was constructed by H. H. Pike & Son, of Cambridge.

The system includes 13.98 miles of pipe, 90 hydrants and 65 gates; there are 269 services. Extensions are recommended. The capacity of the stand-pipe is 367,163 gals., of the high pressure engine, 1,250,000 gals. per day, and of the high duty engine, 2,000,000 gals. per day. The surface of water in the stand-pipe, when full, is 301 ft. above tide. The water is reported to be of good quality. The Water Commissioners are G. W. KELLEY, RICHMOND J. LANE and ZENAS JENKINS; the Construction Committee consist of ZENAS M. LANE, BRAINERD CUSHING and JOHN SPENCE. The Commissioners propose to employ a Superintendent; the necessary services now being performed by J. CARLETON TORREY.

The Boston "Globe", of March 14, reports that the new works are now in operation and that, with the exception of one of the engines, everything is complete.

Cambridge, Mass. The Water Board has issued its report for 1886, being its twenty-second annual report. The work of preparing Fresh pond as a reservoir and storage basin for the water of Stony brook is nearly completed; the Stony brook dam and basin are not yet completed. It is recommended that certain parts of Fresh pond be dug deeper. In addition to new work some repairs will be necessary during the current year, and the distributing reservoirs will have to be emptied and cleared out. The total amount of water pumped during the year was, 1,235,558,878 gallons, of which 317,048,175 gallons were sold by meter and used for street sprinkling, leaving 918,510,703 gallons for domestic use. Daily domestic consumption per capita, 40.59 gallons. During the year, 12,193.25 ft. of iron pipe were laid, from .75-in. to 8 ins. diameter; 43 gates put in, and 20 hydrants. Eight street reservoirs are now in use. Four new Otis steel boilers have been put in, and the old ones taken out. The daily average pumping was 3,387,093 gallons; of which 260,087 were high service and 3,127,006 low service. CHESTER W. KINGSLEY is President of the Board, and HIRAM NEVONS is Superintendent.

Melrose, Mass.—The Water Board has submitted its report for 1886, being its seventeenth annual report. The town is congratulated on its improved water supply which gives a first class system of water-works and a good quality of water. The Board manufactures its own pipe. Several improvements have been made by Malden and Melrose at the pond and gate house. Since the supply has been taken from the reservoir, the water has been of better quality, being drawn from the pond at a greater depth and a gravelly bottom. For the improved water supply the water was turned on from the reservoir Sept. 2, several breaks occurred at first, owing to the increased pressure; the breaks occurred where the pipes had become rusty from imperfect coating, but no breaks occurred in pipes laid by the town. During the year 1 895 ft. of 6-in., 3,406 ft. of 4-in., 1,017 ft. of 2-in. and 164 ft. of 1¼-in. pipe were laid; six hydrants have been put in, and two in Malden, making a total of 117; 21 new gates have been added and 116 new services put in; the total length of mains and distributing pipes is 23.76 miles. The pumping machinery consists of a Knowles compound, condensing, duplex engine; with 8-in. high pressure and 16-in. low pressure cylinders, 12-in. plungers and 18-in. stroke. The plans and specifications for the new work were prepared in 1885 by PERCY M. BLAKE, C. E.; the contract for pipe was awarded to the Gloucester Iron Works, Philadelphia, Pa.; for the reservoir to James Mitchell, of Worcester, Mass., for pumping station and chimney to Peter Graffam, of Malden, Mass., and for machinery to the Knowles Steam Pump Works, New York. ADDISON LANE is Superintendent.

Schenectady, N. Y.—The Sewer Committee has presented its report for 1886. The contract for additional sewers was let in July to BENJAMIN VAN VRANKEN, the lowest bidder; work was commenced Aug. 2, and completed Nov. 25. During the year 230 connections were made, making a total of 610; house connections are 4 ins. in diameter and laid at a minimum grade of 2 per cent. The street sewers have worked well and no stoppages have occurred on any mains or laterals that were flushed by the tanks. Heavier covers are recommended, 125 lbs. for manholes and flush tanks, 50 lbs. for lamp holes. On the old work there are 30 Van Vranken, 1 Field, and 1 Pierson flush tank, and on the new work 5 Van Vranken tanks; the Van Vranken is the most satisfactory. The tanks are set to dump from one to three times in 24 hours. The new sewer work is 16,969.4 ft. long, of which 60 ft. are of iron pipe. For cleaning the sewers balls of sheet copper, from two to three inches smaller than the sewer, are used; they cost about $1 per inch of diameter. The following prices were paid: excavation, under 6 to 12 ft. deep, 12 to 95 cts.; manholes, $30: flush tanks, $35; lamp holes, $5.50; 8-in. pipe, 18 cts. per ft.; iron pipe, 2 cts. per pound; rock, $6 per yd.; repaving and restoring streets, 3½ cts. per ft. The report contains some interesting information. JOHN L. FITZGERALD, is Engineer in Charge of Construction, and WM. B. LANDRETH, Superintendent of Sewers.

Proposals Open.

Steel.—The time for receiving proposals for steel gun forgings and armor plates has been extended until noon, March 22. WILLIAM C. WHITNEY, Secretary of the Navy, Navy Department, Washington, D. C.

Electric Lighting.—E. A. GOODWYN, Chairman of Lighting Committee, Petersburg, Va.

Piling.—About 1,300 lin. ft. of pile and plank protection for approaches and piling for abutments of Eleventh avenue bridge over Cherry creek. W. M. BLISS, City Treasurer, Denver, Col.

Street Cleaning.—Cleaning streets and removing dirt and ashes; from April 1887 to April 1890. DEPARTMENT OF CITY WORKS, Municipal Building, Brooklyn, N. Y. March 24.

Water-Works.—Time for proposals extended from March 15 to March 25. WM. MCKENZIE, Reeve, Morrisburg, Ont., Canada.

Water-Works Supplies.—Iron castings, 400,000 pounds; service box castings, 300,000 pounds; corporation castings, 9,000 pounds; brass castings, 9,000 pounds. H. T. ROCKWELL, Chairman, Water Board, Boston Mass. March 25.

Pipe Laying.—Trenching and laying pipe. Plans and specifications at the office of the Water Engineer, City Hall. THOMAS J. NEVILLE, Clerk of the Executive Board, Rochester, N. Y. March 25.

Street Sprinkling.—Bids to be a price per week for each street. Plans and specifications at the office of the City Surveyor. THOMAS J. NEVILLE, Clerk of the Executive Board, Rochester, N. Y. March 25.

Steam Heating Apparatus.—Steam pipe, radiators, fittings, etc. HENRY H. PORTER, President, Department of Public Charities and Correction, 66 Third avenue New York City. March 25.

Water-Works Supplies.—Iron pipe and specials, machine iron castings, valve boxes, furnace grates, brass castings, ferrules. THOMAS G. SMITH, President, Board of Public Affairs, Cincinnati, O. March 26.

Hydrants, Stop Cocks, Etc.—Stop cocks, hydrants, wooden hydrant boxes, cast iron stop cock boxes. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers street, New York City. March 28.

Sewers and Paving.—Curbing, flagging and sewers. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers street New York City. March 28.

Sidewalk.—Concrete or stone sidewalk and curbing, 1¼ mile. FRED J. H. RICKON, Engineer of the Board of Commissioners, Sidewalk District No. 1. Little Rock, Ark. March 29.

Gravel Filling.—Filling streets on South Boston flats. JOHN E. SANFORD, Chairman, Harbor & Land Commissioners, Commonwealth Building, Boston, Mass. March 30.

Dredging.—Improving harbor at Redwood, Cal. Col. G. H. MENDELL, U. S. Engineer Office, San Francisco, Cal. March 30.

Bulkhead.—From W. 77th to W. 78th street, North river. THE BOARD OF DOCKS COMMISSIONERS, Department of Docks, Pier A., North River, New York City. March 30.

Water-Works.—Engineer, JOHN YOUNG. WILLIAM A. WADSWORTH, President, Board of Water Commissioners, Geneseo, N. Y. March 31.

Bridge.—Iron bridge with 50 ft. draw; stone center pier and approaches; across Pine river at St. Clair. Contractors to furnish plans and details of construction. JOSEPH BRASO, St. Clair, Mich. April 1.

Skylights.—At new Pension Building Washington; 33 skylight over record rooms. M. C. MEIGS, Supervising Engineer and Architect, 1316 N. street, N. W., Washington, D. C. April 4.

Dredging.—Improving Newtown creek. Lieut. Col. WALTER MCFARLAND, U. S. Engineer Office, Houston and Greene streets, New York City. April 6.

Pipe.—Iron water pipe, about 840 ft., and fittings Col. JOHN M. WILSON, Office of Public Buildings and Grounds, Pennsylvania avenue, Washington, D. C. April 7.

Dike.—In the Delaware river from the lower end of Reedy island. Lieut. Col. HENRY M. ROBERT, U. S. Engineer Office, Philadelphia, Pa. April 8.

Dredging.—Cedar Keys harbor, Tampa bay and Manatee river; total amount available for the three works, $25,000. Capt. W. M. BLACK, U. S. Engineer Office, Jacksonville, Fla. April 11.

Hand Rail.—On the Central viaduct; 8,250 ft. Plans and specifications at the office of the City Engineer. THE BOARD OF IMPROVEMENTS, Cleveland, O. April 14.

Viaduct Work.—Timber trestle, grading, curbing and drainage of a portion of Kingsbury viaduct. THE BOARD OF IMPROVEMENT, Cleveland, O. April 14.

Street Work.—Grading, draining, paving and improving; bids for fire-brick and Medina dressed sandstone paving. THE BOARD OF IMPROVEMENTS, Cleveland, O. April 14.

Jetty. At the entrance to Galveston harbor; to be composed of stone and clay; amount available, $280,000. Major O. H. ERNST, U. S. Engineer Office, Galveston Tex. April 16.

Pumping Engine Supplies.—Two large steel spur wheels and pinions, four low pressure piston rods and sleeves (two each for engines No. 1 and No. 2), four valve rods, four pump piston rods and sleves, four trunk joints for air pumps. Particulars may be obtained of the Superintendent. THOMAS HUNTER, Chairman, Water-Works Committee, Toronto, Canada. April 25.

Signal Office Supplies.—Stationery, April 18; telegraph supplies, April 19; paper, lithographing, carbon paper, etc., April 20; draughting material, flags, etc., April 21; lumber, chemicals, etc., April 22; hardware and instruments, April 23. A. W. GREELY, Chief Signal Officer, U. S. A., Washington, D. C.

Contracting.

Shore Protection.—At Dunkirk, N. Y., it is proposed to drive piles for the protection of the lake front. Address the Street Commissioner.

Piling.—Allen & Nelson, of Seattle, Wash. Ter., have been awarded the contract for piling on the Seattle, Lake Shore & Eastern R. R.

Steam Heating Apparatus.—The contract for heating the new State House at Columbia, S. C., has been awarded to Thomas C. Bassher & Co., of Baltimore, Md.

Asphalt Paving.—At St. Paul, Minn., the following contracts have been awarded to the Warren-Scharf Asphalt Paving Co., of New York: Western avenue, $11,620; Holly avenue, $30,270; Portland avenue, $31,125; Dayton avenue, $79,400.

Dry Dock.—The Chesapeake Dry Dock & Construction Co., of Newport News, Va., has purchased land for the dock, workshops, etc. The contract for the construction of the dock has been awarded to J. E. Simpson, of New York City.

The Creosote Lumber & Construction Co. will establish extensive creosoting works at Fernandina, Fla.; the plant is being erected and will be in operation in about three months. E. R. BRINK, of Fernandina, is Vice President and Secretary.

Bridge Contract.—The Rome, Watertown & Ogdensburg R. R. Co. has awarded the contracts for a single track bridge over the river at Rochester, N. Y., to the Phœnix Bridge Co., for the superstructure, and James D. Casey, of Rochester, for the masonry.

Roads.—The Christian County Union Turnpike Co. has been organized at Hopkinsville, Ky., with a capital stock of $80,000 which may be increased to $100,000. The company will build 40 or 50 miles of turnpike in the county during spring and summer. President, E. P. CAMPBELL; Secretary, S. C. MERCER.

Decatur Iron Bridge & Construction Co.—Work has been commenced on the erection of the buildings for this new company, and the plant will be in operation in four months. Capital stock, $300,000; cash capital, $100,000. GEORGE S. MOOAR, President; C. D. OLMSTEAD, Secretary; both of Birmingham, Ala.

Water Works Supplies.—At Buffalo, N. Y., the Water Commissioners have awarded the following contracts: Pipe, the Buffalo Cast Iron Pipe Co.; valves, the Eddy Valve Co., Waterford, N. Y.; hydrants, the Howard Iron Works, Buffalo; cocks, Collignon & Grimard, Buffalo; valve boxes, A. W. Morgan, Buffalo; tile, the Buffalo Sewer Pipe Co.; repairing pavements, P. B. McNaughton.

Dredging.—The following proposals for dredging in Back Cove, Portland, Me., have been received by Major JARED A. SMITH, U. S. Engineer Office, Portland, Me.: James E. Chapman, Boston, Mass., 16 cts. per cu. yd. in situ; Moore & Wright, Portland, Me., 18 cts.; Thomas Symonds, Leominster, Mass., 27 cts.; Hamilton & Soule, Chebeague, Me., 33 cts. The contract was awarded to James E. Chapman.

Masonry.—The following proposals were opened March 7, by Lieut. Col PETER C. HAINS, U. S. Engineer Office, Washington, D. C., for the construction of masonry of reservoir outlet and wing walls: Nolan, New York, $28,683; Geo. Pierce, Frankfort, Me., $29,248.65; Lane & Mainate, Washington, D. C., $23,326.60; Flannery Bros., Washington, D. C., $33,965.50; F. H. Smith, New York, $36,448.50; T. H. Lyons, Baltimore, Md., $45,388.80; Ormen & Stewart, Nashville, Tenn., $58,123.81.

Dikes.—The following proposals have been received by S. T. ABERT, U. S. Engineer Office, Washington, D. C.: On the Mattaponi river, Va., at Robinson's bar; Duncan & Gillies, Baltimore, Md., $2.49 per lin. ft.; Francis H. Smith, New York City, $3.45; I. V. Hoag, Jr., Pittsburg, Pa., $4.40.—On the Pamunky river, Va., at Saidmore and Spring bars; Francis H. Smith, New York City, $3.55 per lin. ft.; I. V. Hoag, Jr., Pittsburg, Pa., $4.40.

Earth Filling.—The following proposals have been received for earth filling around the Washington monument: Thomas H. Lyons, 39 cts. per cu. yd.; John H. Staats, Jersey City, N. J., 39¼ cts.; Gilbert Petersen, Washington, 42¼ cts.; Blundon & Fletcher, Washington, 42½ cts.; Davis & Campbell, Washington, 44 cts.; Frank P. Murphy, Washington, 45 cts.; Albert Gleason, Washington, 48¼ cts.; William A. Mohler, Washington, 49 cts.

Street Cleaning.—At Brooklyn, N. Y., proposals were opened recently for a three year's contract for cleaning the streets and removing ashes, from April, 1887, to April, 1890; the appropriations for each year are $160,000, $165,000, $170,000. Henry Berau, street cleaning, $35 per mile, removing ashes, $155,000, $165,000, $175,000. Peter Blake, $30, $31, $33 per mile; $135,000, $150,000, $175,000. The specifications call for 5,000 miles of street cleaning per year, and it is claimed that the appropriations are insufficient. All the bids were rejected and the work readvertised.

Piles.—The following proposals were opened March 7, by Capt. CHAS. E. L. B. DAVIS, U. S. Engineer Office, Milwaukee, Wis., for furnishing piles for improving the harbor at Oconto, Wis.: Leathem & Smith, Sturgeon Bay, Wis.: 200 26-ft. piles, and 200 24-ft. piles, 9¾ cts. per lin. ft.; total, $937.50. J. H. Elmore & Co., Green Bay, Wis., 10 cts. per lin. ft. $1,000. The contract was awarded to Leathem & Smith.

Water Works Supplies.—The Water Committee of Allegheny, Pa., has awarded contracts as follows: J. R. Hutchinson, stop gates and fire plugs; Bailey, Farrell & Co., pig lead, $1.75 per 100 pounds; Dennis Long & Co., pipe, branches, etc.; W. S. Evans & Co., castings; McKay Manufacturing Co., ferrules; Samuel Hastings, stop cock boxes, etc.; Rees, Shook & Co., fire plugs. Kear & Lawrence, of Minersville, Pa., were granted leave to clean 1,000 ft. of 6-in. pipe at 15 cts. per ft., if successful a contract for cleaning three miles of pipe will be given them.

A Contractors Claim.—When the building committee of the court house, at Oshkosh, Wis., advertised for bids for steam heating, they failed to put in a clause giving them the power to reject any or all bids. The contractors made their own plans and specifications but finally the board decided not to heat the building by steam. Messrs. Kruse & Barker, of Milwaukee, Wis., then brought in a bill for $134 for preparing plans and specifications. After some discussion the Board rejected the bill on the ground that they did not employ anyone to make plans or specifications, but invited proposals, to make which such plans and specifications were necessary.

Street Work.—At St. Paul, Minn., the contract for stone sidewalks has been awarded by Wm. BARRETT, President of the Board of Public Works, to Lauer Bros., of St. Paul, at the following prices: Berea sandstone, 3-in., 30½ cts. per sq. ft.; 4-in., 34½ cts.; 5 in., 41 cts.; Kettle River stone, 31½, 35½, 42 cts.; Bedford stone, 36 and 37 cts. for 24 to 36 and 36 to 50 sq. ft. of 3-in., 41 and 42 cts. for 4-in., 49 and 50 cts. for 5 in.; earthwork, 40 cts. per cu. yd.; masonry, $4 per cu. yd.; brickwork, $14 per 100; granite curb, $1.08 per lin. ft.; relaying curb, 10 cts. per lin. ft.; relaying pavement, 60 cts. per sq. yd.; relaying stone walk, 5 cts. per sq. ft.; wrought-iron, 4½ cts. per pound. The other bidders were Hennessy Bros. Agnew & Cox, and Ulmer & Smith.

Crib Work.—The following proposals have been received by Lieut. COL. O. M. POE, U. S. Engineer Office, Detroit, Mich., for crib work at the harbor of refuge, Lake Huron, Mich.: Timber; Brooks, Joslyn & Co., Port Huron, Mich., white pine plank, $21.50 per 1,000 ft. B. M.; white oak plank, $30; total, $14,679.72; Henry Howard & Co., Port Huron, Mich., $22, $30, $15,001.30; Carkin, Stickney & Cram, East Saginaw, Mich., $23.50, $21, $15,710.42.—Iron: Ducharme, Fletcher & Co., Detroit, Mich., blunt bolts, 2.54 cts. per pound; pointed bolts, 2.75 cts.; boat spikes 2.87 cts. (½-in.), 2.96 (⅝-in.); ladder iron, 2.8 cts., total $2,199.38. Mark Packard, Buffalo, N. Y., 2.99, 2.99, 2.99 and 2.50 cts., $2,441.28. Carkin, Stickney & Cram, East Saginaw, Mich., 3¾, 3¾, 3¾ cts., no bid for ladder iron; $3,091.47.—Stone; McNeillis & Johnson, Port Hope, Mich., $4.80 per cord, total, $7,200. George W. Jenks, Sand Beach, Mich., $5.97, $8,955. Carkin, Stickney & Cram, East Saginaw, Mich., $10, $15,000.

Pier Work.—The following proposals were opened March 8, by Major L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O., for pier extension and repairs to pier at Fairport harbor, O.: Kerr, Stang & Gillmore, Lorain, O.; timber, hemlock, $22 per 1,000 ft. B. M., white pine, $31, white oak, $30; stone, filling, $5.60 per cord, rip-rap, $5.60; iron, drift bolts, 2¾ cts. per pound, spikes, 4 cts. per pound, wharf bolts, 4 cts. per pound; treenails, $5 per 100; dredging, 65 cts. per cub. yd.; total, $14,601.17. Cortland D. Merry, Burg Hill, O., timber, $21.90, $32, $35; stone, $5.25, $4.50; iron, 3¼, 3½ and 4¼ cts.; treenails, $4; dredging, 40 cts.; total, $14,953.53. L. P. & J. H. Smith, Cleveland, O.; timber, $21, $31, $32; stone, $6, $6; iron, 4, 5 and 5 cts.; treenails, $5; dredging, 60 cts.; total, $15,017.24. The contract has been awarded to Kerr, Stang & Gillmore, Lorain, O.

Bridge.—The following proposals were opened March 7 by Lieut. Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C., for the reconstruction of the Aqueduct bridge at Washington: Southern approach; John W. Clarke, $7,275; Breen & Teely, Alexandria, Va., $8,833; Thos. W. Widdicombe, Washington, D. C., $10,200; H. A. Ramsey, Baltimore, Md., $11,850; King Iron Bridge & Manufacturing Co., Cleveland, O., $15,490; Wrought-Iron Bridge Co., Canton, O., $15,490.

Reconstruction of bridge; Mount Vernon Bridge Co., Mount Vernon, O., $80,905.50; Morse Bridge Co., Youngstown, O., $81,727.50; King Iron Bridge & Manufacturing Co., Cleveland, O., $89,283.50; Wrought Iron Bridge Co., Canton, O., $85,429.90; Pittsburg Bridge Co., Pittsburg, Pa., $88,816; Penn Bridge Co., Beaver Falls, Pa., $89,055; H. A. Ramsey, Baltimore, Md., $93,992; Keystone Bridge Co., Pittsburg, Pa., $104,127; Berlin Iron Bridge Co., East Berlin, Conn., $104,141.50.

Galveston Street Paving.—The use of shell paving was abandoned in 1872 and wood pavement tried. This experiment was deemed so successful that more was laid each year until now fifty-two blocks are so paved. This pavement is reported to be in excellent condition and only slight repairs have been found necessary.

Water-Works.—The following proposals for a system of water-works have been received by the mayor of Waco, Tex.: Inman Bros., New York City; 20 years contract, the city to take 200 hydrants at $50 each; the works to have a daily capacity of 4,000,000 gallons and to be completed in one year. M. P. Kelly & Co., Paris, Tex.; 25 years contract, 100 hydrants at $60 each or 200 at $50. Samuel R. Bullock & Co., New York City; 20 years contract; 125 hydrants at $60 each, or 200 at $50; daily capacity of works, 5,000,000 gallons. The city stipulates for a supply for a population of 50,000; the stand-pipe system, instead of reservoirs, to be adopted. The Waco Water Co. will oppose the proposed new works.

Railroad Contracts.—Henley & Persons have the contract for a three mile loop of the Memphis & Charleston R. R., through Sheffield, Ala., where shops will be built. At present the line runs through Tuscumbia, but the change will leave out that city and Montgomery.

Tate, Dunavant & DeBardeleben have the contract for the extension of the Georgia Central R. R. from Goodwater to Leeds, Ala. This contract embraces some of the heaviest work in the State, including two tunnels through Oak and Coosa mountains, the former 1,250 and the latter 2,100 ft. long.

Sewers.—At Pittsburg, Pa., the Council has passed the Negley Run sewer ordinance. The contract for the Washington avenue sewer has been awarded to W. T. Dunn & Co., for $36,250.

At Toronto, Canada, sewer contracts have been awarded to John McKnight, and other sewers have been recommended by City Engineer SPROATT.

At Binghamton, N. Y., trunk sewers are proposed; there are very divided opinions on the subject.

At Manchester, N. H., some amount of sewer work will be done this season.

At Brooklyn, N. Y., it is proposed to provide storm sewers in the Eastern District.

Atlanta Bridge Works.—Messrs. Miles & Horn, contractors for the new capitol at Atlanta, Ga., have, in conjunction with Mr. GRANT WILKINS, engineer and formerly proprietor of the Atlanta Bridge Works, organized a company to reopen the bridge works and increase their capacity. A rolling mill will be erected, and the firm will undertake the manufacture of the Brosius steel wagon axle, in addition to the bridge work, and will also do a general iron business. The existing bridge plant is very complete and Mr. WILKINS has now under contract several thousand dollars worth of work. The capital stock of the new company is $150,000, all of which is reported to be taken, and all details closed.

Iron Work.—The following proposals have been received by M. E. BELL, Supervising Architect, Treasury Department, Washington, D. C.: For custom house at Richmond, Va.; Asa Snyder & Co., $5,765; Snead & Co. Iron Works, $5,895; Dearborn Foundry Co., $5,995; Marshall Foundry & Construction Co., $7,499.80; F. I. Meyers Manufacturing Co., $7,600. The lowest bid has been accepted.—For court house and post office at Macon, Ga.; Snead & Co. Iron Works, $3,097; Dearborn Foundry Co., $3,700; Haugh, Ketcham & Co., $4,015.45; Marshall Foundry & Construction Co., $4,255.80; F. I. Meyers Manufacturing Co., $6,017.94. The lowest bid has been accepted.—For court house and post office at Harrisonburg, Va., I. H. Van Dorn, Cleveland, O., $897.50; Champion Iron Fence Co., $1,010.5; Snead & Co. Iron Works, $1,222; Manly & Cooper Manufacturing Co., Philadelphia, Pa., $1,375; P. Bradley's Sons, $1,399; McCarthy & Corbett, Washington, D. C., $1,975.

Street Work.—At Atlanta, Ga., the following proposals have been received: Thomas G. Crusselle, rubble stone work for sewers, $2.19; excavation, 19 cts.; brick work (city to furnish cement) $11 per M. T. Backus, excavating and hauling earth, 15½ cts. per cu. yd.; excavating hard pan, 35 cts.; excavating rock, $1.35; lumber, $11.75; brick work, $11 per M. M. E. Maher, Belgian blocks, $2.09 per sq. yd.; rubble stone, $1.09; macadam, $1.08; culvert, $2.92 per perch; brick for sewers, $12.68; lumber, $11.40; excavating (culverts), 22½ cts., (sewers) 24 cts. Atlanta Granite Co., Belgian block, $1.99½; rubble, $1.65. T. B. Redmond, granite blocks, $1.87 per sq. yd.; rubble paving, $1.06; macadam, $1.07. Culver, Rollo & Co., rubble paving, $1.16. S. H. Venable & Co., Belgian blocks, $1.40¾; rubble paving, 82 cts.; macadam, 84 cts.; curbing, 58¾ cts.

At Toronto, Canada, the following contracts have been awarded; William Cathro, cedar block paving, 85 cts.; curbing, 22 cts.; crossing plates, $3. William Jones, paving, 76 cts.; curbing, 18 cts.; crossing plates, $2.70.

At Philadelphia, Pa., certain amounts of granite, sheet asphaltum and vitrified brick paving have been reported favorably by the Highway Committee of Councils.

Railroads, Bridges and Canals.

Newport & New York Rapid Transit Co.—This company has been organized to cut a canal across Conanicut island opposite Newport, R. I., for a ferry steamer landing at Eaton's Ferry on the mainland, whence a branch line would be built to the Shore Line. The canal would be about .75 mile long, and is estimated to cost about $50,000. The charter is expected to be granted in May, and the work would then be done this summer. It would shorten the present time from Newport to New York by one hour. HENRY BULL, of Newport, R.I., and ROWLAND N. HAZARD, of Providence, are interested.

Macon & Tuscaloosa R. R.—The line is being surveyed between Tuscaloosa, Ala., and Macon, Miss., 60 miles; the grades are light at the western end and moderately heavy at the eastern end. There are two bridges of importance, over the Tombigbee and Warrior rives. The contracts are expected to be let shortly. President, R. C. PATTY, Macon, Miss. Information may be obtained of Cochran & Fitts, Tuscaloosa, Ala.

The Market Street Cable Road, (San Francisco), is reported to be buying a controlling interest in the Geary Street Cable Road of the same city. They have a franchise for the extension of the Geary street line to Cliff House, and propose to build it. The same company has commenced work on the Castro street line, the fifth in their system. Another company is building a cable road on Jackson street.

Bridges.—The Manhattan Beach Improvement Co., has offered to bridge Sheepshead bay at a cost of $30,000: the matter will be considered April 5.——At Sioux City, Ia., GEO. MORISON, C. E., has been in consultation with the bridge company; work will probably be commenced this season.——At New Orleans, La., the Smith Bridge Co., of Toledo, O., is building three steel bridges over the canal.——It has been decided that the Government will not interfere with the bridges at St. Paul, Minn., on the ground of obstructing traffic.——At San Jose, Cal., plans for bridges over Los Gatos and Guadalupe creeks have been prepared by City Engineer PIEPER.——At Fort Madison, Ia., the question of rebuilding the Augusta bridge has been discussed; a single span is favored: J. B. Diver & Co., the contractors, are endeavoring to raise the tubes that were knocked off the foundation by the ice.——At St. Louis Mich., an iron bridge will be built across Pine river.——At Holyoke, Mass., the Connecticut River R. R. Co. will build two double track bridges, and will do other bridge work.——At St. Louis, Mo., it is reported that the Merchants' bridge will not be built, MR. JAY GOULD having purchased the terminal property.——At Mexico, Mo., a wooden bridge is to be erected by the Chicago & Alton and Wabash railroads; cost $2,600.——At Tonawanda, N. Y., work is progressing on the new draw bridge for the N. Y. C. & H. R. R. R. Co.; the work is being done by Louis Harbrecht.

At Memphis, Tenn., the Memphis Bridge Co. will erect its structure shortly.——At Baltimore, Md., a viaduct is projected; Engineer LATROBE has submitted plans to the Merchants & Manufacturer's Association.——The Wabash R. R. Co. will repair several of its bridges.——At Buffalo, N. Y., the contract for a stone arch bridge has been awarded to Frank E. Winter at $3,639; and the contract for an iron bridge to D. W. McConnell, at $3,750.——At Adairsville, Ga., new bridges are to be built by the road commissioners.——At Bartlett, N. H., a bridge is proposed across the Saco river.——An iron bridge is to be built across Flint river between Oglethorpe and Montezuma, Ga.——At Rochester, N. Y., the construction of the Elwood avenue bridge has been ordered, at a cost of $35,000, by the Supervisors. Other bridges are projected.

Railroad Surveys.—Union Pacific R. R. A line has been surveyed from a point on the line in Kansas to Wichita; the work was in charge of T. D. PAUL.——Pittsburg, Virginia & Charleston R. R. Surveys are being made from Brownsville, Pa., to Morgantown, W. Va. J. N. DUBARRY, of Philadelphia, president.——Missouri Pacific R. R. A survey has been made by COL. G. JENNINGS, from Boonville, Mo., to Jefferson City, for the Boonville and Lexington extension.——Kansas & Arkansas Valley R. R. A survey is being made for the 100 miles of road recently ordered to be constructed from Van Buren, Ark., to the Indian Territory.——Chicago, Milwaukee & St. Paul R. R. A survey is being made for an extension to Montecello, Wis.——New York, Ontario & Western R. R. A survey has been made for a line to connect with the Carthage & Adirondack road at Carthage, N. Y.——Dallas & Waco R. R. The line is located as far as Italy, Tex., whence it will be pushed on to Milford.——New York & Boston Rapid Transit R. R. An independent line is under survey from Boston to New York.——Burlington & Missouri R. R. A line has been surveyed from the Republican river, in Nebraska, southwest up the Beaver creek valley, 130 miles.——South Atlantic & Northwestern R. R. The line is being surveyed from Smithville, N C., to Bristol, Tenn.——Fort Dodge R. R. SAMUEL J. ROCKWELL, Chief Engineer, has been in Council Bluffs, Ia., surveying for the line to enter that city.——Chicago, Burlington & Quincy R. R. Engineers have been making a survey of the old line from Canton, through Memphis, to Moravia, Ia., the franchise for which was acquired by the company when work was abandoned by the former owners.——Beaver Creek R.R. Another survey is to be made from the summit to Deansville, N. Y., and the N. Y., Ontario & Western R. R. Co. is being negociated with; the engineer is Mr. CHILDS.——The Tuscaloosa Railroad & Improvement Co. has put under survey a line from Tuscaloosa north to the junction of the Kansas City, Memphis & Birmingham R. R. and the Georgia Pacific R.R. Address Cochran & Fitts, Tucaloosa, Ala.

Bridge Companies.—At Des Moines, Ia., the Clinton & Illinois Bridge Co., has been incorporated with a capital stock of $250,000.——At Cincinnati, O., the Central Railway & Bridge Co. and the Central Bridge Co. have been consolidated under the name of the Central Railway & Bridge Co. of Cincinnati and Newport.

Shinnecook Canal.—At Albany, N. Y., the Committee on Appropriations has voted to insert in the Supply bill an item of $22,000 for the completion of the Shinnecook canal; $25,000 had been asked for by Assemblyman REEVES.

Des Moines, Osceola & Southern Ry.—The road has been sold for $750,000 to E. WOOLMAN, of Portland, Me., representing the bondholders. The line extends from Des Moines, Ia., to Carnesville, Mo., a distance of 113 miles, and it is expected that it will be changed from narrow to standard gauge and be extended to St. Joseph and Kansas City.

Chicago, Fort Scott & Texas R. R.—The survey has been completed from Higgensville to Warrensburg, and grading will soon be started on this division. The preliminary survey is being pushed from the latter place to Fort Scott, Kan., with El Paso, Tex., as the southern terminus. S. W. LEE, formerly with the Atchison, Topeka & Santa Fè R. R. Co., is Chief Engineer; FRED JAMES of Mercer, Pa., is locating engineer and WM. V. ALFORD, of Butler, Mo., is Topographical Engineer.

Steam Heating.—The Board of Aldermen, Boston, Mass., has passed resolutions to examine the system of heating as operated by the New York Steam Co. A committee has been in this city for the purpose of inspecting the system.

Hartford & Connecticut Western R. R.—A syndicate has been organized by Philadelphia parties to purchase a controlling interest in this road. The intention is to build lines to connect with the Central Massachusetts R. R. and the Poughkeepsie bridge, and form a new trunk line system from New England to the west.

Canadian Pacific Ry.—The new extension to the sea runs from the end of the track of the International Railway of Canada, near the international boundary easterly across the State of Maine to a junction with the Maine Central R. R. at Mattawamkeag, 128 miles of new line. There will be about 30,000 cu. yds. of earth, solid and loose rock per mile. The line is partially under contract, and contractors are getting in supplies. Work will be pushed through with the opening of the season.

Collapse of a Tunnel.—The tunnel at West Alexander, a few miles west of Washington, Pa., on the Wheeling & Pittsburg division of the Baltimore & Ohio R. R., caved in on March 12.

U. S. ENGINEER OFFICE,
ROCK ISLAND, ILL., March 15th, 1887.

SEPARATE SEALED PROPOSALS, in duplicate, will be received at this office until 2 P. M. on the 15 day of April, 1887, for furnishing one thousand (1000) barrels of hydraulic cement for use in the construction of the Dry Dock at the Des Moines Rapids Canal. Proposals will be accompanied by a written guarantee that in case the bid be accepted, contract will be entered into with good and sufficient security within ten (10) days notice of such acceptance.

Blanks, on which proposals must be made, containing specifications and detailed information, may be obtained on application.

A. MACKENZIE,
12-4t Major of Engineers.

IN PREPARATION. READY APRIL 1st

Poor's Directory of Railway Officials

FOR 1887.

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Office of PURCHASING COMMITTEE, WABASH, ST. LOUIS AND PACIFIC RAILWAY, 195 Broadway.
New York, October 5, 1886.

Messrs. H. V. & H. W. POOR, 70 Wall Street, City.

Gentlemen:—I have received a copy of your Directory and find it to be a very complete and useful work of the kind. The indexes to officials and advertisements are particularly convenient, and when extended as you propose in the coming year will make the volume a practical business directory. Purchasing agents and others having these matters to classify will appreciate the great utility of the arrangement.

The book ought to be a a success.

Yours truly,
(Signed) O. D. ASHLEY, *Secretary.*
Wabash, St. Louis and Pacific Railway Co.

Office of the GENERAL PASSENGER AGENT, NEW YORK, LAKE ERIE AND WESTERN RAILROAD CO.
New York, September 24, 1886.

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